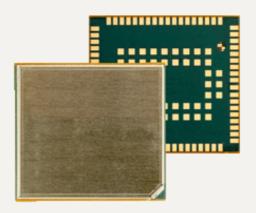# Cinterion® ELS62

Hardware Interface Description

Version   00.804
DocId: ELS62_HID_v00.804

THALES

Document Name:	**Cinterion® ELS62 Hardware Interface Description**
Version:	**00.804**
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Contents

Tables

Figures

1 Introduction

This document[1] describes the hardware of the Cinterion® ELS62 module. It helps you quickly retrieve interface specifications, electrical and mechanical details and information on the requirements to be considered for integrating further components.

1.1 Product Variants

- Cinterion® ELS62-W Module
- Cinterion® ELS62-E Module
- Cinterion® ELS62-I Module
- Cinterion® ELS62-BR Module
- Cinterion® ELS62-C Module

1.2 Key Features at a Glance

Feature	Implementation
General	
Frequency bands	ELS62-W GSM/GPRS/EDGE: 850 (BdV) / 900 (BdVIII) / 1800(BdIII) / 1900 (BdII) LTE: 2100(Bd1) / 1900(Bd2) / 1800(Bd3) / 2100(Bd4) / 850(Bd5) / 2600(Bd7) / 900(Bd8) / 800(Bd20) / 700(Bd28) /TD2600(Bd38) / TD2300(Bd40) / TD2500(Bd41)[2] / 2100(Bd66) ELS62-E GSM/GPRS/EGPRS bands: 900 (BdVIII) / 1800(BdIII) LTE bands: 2100(Bd1) / 1800(Bd3) / 2600(Bd7) / 900(Bd8) / 800(Bd20) / 700(Bd28) ELS62-I GSM/GPRS/EGPRS bands: 900 (BdVIII) / 1800(BdIII) LTE bands:2100(Bd1) / 1800(Bd3) / 850(Bd5) / 900(Bd8) /TD2300(Bd40) / TD2500(Bd41)[2] ELS62-BR GSM/GPRS/EGPRS bands: 850 (BdV) / 900 (BdVIII) / 1800(BdIII) / 1900 (BdII) LTE bands: 2100(Bd1) / 1800(Bd3) / 850(Bd5) / 2600(Bd7) / 900(Bd8) / 700(Bd28) ELS62-C GSM/GPRS/EGPRS bands: 900 (BdVIII) / 1800(BdIII) LTE bands: 2100(Bd1) / 1800(Bd3) / 850(Bd5) / 900(Bd8) / TD2000(Bd34) /TD2600(Bd38) / TD1900(Bd39) / TD2300(Bd40) / TD2500(Bd41)[2]

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1. The document is effective only if listed in the appropriate Release Notes as part of the technical documentation delivered with your Thales product.
2. Frequency range of Band 41 is 2535-2675MHz

Feature	Implementation
Output power (according to Release 99)	Class 4 for 850 (BdV) / 900 (BdVIII) GMSK Class 1 for 1800(BdIII) / 1900 (BdII) GMSK Class E2 for 850 (BdV) / 900 (BdVIII) 8-PSK Class E2 for 1800(BdIII) / 1900 (BdII) 8-PSK
Output power (according to Release 99)	Class 3 for LTE 2100,LTE FDD Bd1 Class 3 for LTE 1900,LTE FDD Bd2 Class 3 for LTE 1800,LTE FDD Bd3 Class 3 for LTE 2100, LTE FDD Bd4 Class 3 for LTE 850, LTE FDD Bd5 Class 3 for LTE 2600, LTE FDD Bd7 Class 3 for LTE 900, LTE FDD Bd8 Class 3 for LTE 800, LTE FDD Bd20 Class 3 for LTE 700, LTE FDD Bd28 Class 3 for LTE 2000, LTE TDD Bd34 Class 3 for LTE 2600, LTE TDD Bd38 Class 3 for LTE 1900, LTE TDD Bd39 Class 3 for LTE 2300, LTE TDD Bd40 Class 3 for LTE 2500, LTE TDD Bd41 Class 3 for LTE 2100, LTE FDD Bd66
Power supply (see Section 2.1.2 and Section 3.4)	Normal operation: 3.2V to 4.5V Extended operation: 3.0V to 3.2V (target) Typ value is 3.8V
Operating temperature (board temperature) (See Section 3.5)[1]	Normal operation: -20°C to +85°C Extended operation: -30°C to +90°C (target)
Physical (See Section 4.1)	Dimensions: 27.6mm x 25.4mm x 2.25mm (Typical) Weight: approx. 3.3g
RoHS	All hardware components fully compliant with EU RoHS Directive
LTE features	
3GPP Release 13	UE Cat.1bis supported DL 10.2Mbps, UL 5.2Mbps
GSM/GPRS/EGPRS features	
Data transfer	GPRS: • Multislot Class 12 • PBCCH support • Mobile Station Class B • Coding Scheme 1 – 4 EGPRS: • Multislot Class 12 • PBCCH support • Mobile Station Class B • Downlink coding schemes - MCS 1-9 • Uplink coding schemes - MCS 1-9
SMS	Point-to-point MT and MO Cell broadcast Text and PDU mode Storage: SIM card plus SMS locations in mobile equipment
Software	
AT commands	Hayes 3GPP TS 27.007, TS 27.005, Thales Cinterion®AT commands for compatibility

Feature	Implementation
SIM Application Toolkit	SAT letter classes b, c, e; with BIP
Audio	Support for Voice over LTE (VoLTE), i.e. Voice Service via IMS (IP-based Multimedia Subsystem) and CSFB
Firmware update	Generic update from host application over ASC0 or USB modem.
Interfaces	
Module interface	Surface mount device with solderable connection pads (SMT application interface). Land grid array (LGA) technology ensures high solder joint reliability and allows the use of an optional module mounting socket. For more information on how to integrate SMT modules see also [4]. This application note comprises chapters on module mounting and application layout issues as well as on additional SMT application development equipment.
USB (see Section 2.1.3)	USB 2.0 High Speed (480Mbit/s) device interface, Full Speed (12Mbit/s) compliant.
2 serial interfaces (see Section 2.1.4 and Section 2.1.5)	ASC0 (shared with GPIO lines): • 8-wire modem interface with status and control lines, unbalanced, asynchronous • Auto baud rates: 1200bps to 230,400bps(not include 2400bps) • Adjustable baud rates: 300bps to 921,600bps • Supports RTS0/CTS0 hardware flow control. • Supports 0xON/0xOFF software flow control. ASC1 (shared with GPIO lines): • 4-wire, unbalanced asynchronous interface • Auto baud rates: 1200bps to 230,400bps(not include 2400bps) • Adjustable baud rates: 300bps to 921,600bps • Supports RTS1/CTS1 hardware flow control
Audio (see Section 2.1.7)	1 digital audio interface (DAI), shared with GPIO lines 1 analog audio interface (AAI)
UICC interface (see Section 2.1.6)	Supported SIM/USIM cards: 3V, 1.8V
GPIO interface (see Section 2.1.9)	20 GPIO lines comprising: 4 GPIO lines shared with ASC0 interface 4 GPIO lines shared with ASC1 interface 5 GPIO lines shared with DAI interface 3 GPIO lines shared with network status indication, fast shutdown, pulse counter, 4 GPIO lines not shared
Status (see Section 2.1.11.1)	Supports status indication LED.
Fast shutdown (see Section 2.1.11.4)	Supports fast shutdown interrupt signal.
Antenna tuner	2 GPIO for antenna tuner control (TBD).
Antenna interface pads (see Section 2.2)	50Ω. GSM/LTE antenna.
Power on/off, Reset	

Feature	Implementation
Power on/off	Switch-on by hardware signal ON Switch-off by AT command Switch off by hardware signal FST_SHDN instead of AT command Automatic switch-off in case of critical temperature or voltage conditions
Reset	Orderly shutdown and reset by AT command Emergency reset by hardware signal EMERG_RST
Evaluation kit (For ordering information see Section 7.1)	
Evaluation module	ELS62 module soldered onto a dedicated PCB that can be connected to an adapter in order to be mounted onto the DSB75 or DSB-Mini.
DSB75	DSB75 Development Support Board designed to test and type approve Thales modules and provide a sample configuration for application engineering. A special adapter is required to connect the ELS62 evaluation module to the DSB75.
LGA DevKit	LGA DevKit is designed as a generic development adapter for LGA MODULE. With the LGA DevKit it is no longer necessary to connect the evaluation modules to an adapter for test and development purposes. LGA DevKit may operate stand-alone without the need of any further tools or devices, or it can be operated with a port extender, for instance the DSB75 or DSB-Mini as an adapter between the module and further external applications.

1. The board temperature is corresponding to the measured chipset temperature.

1.3   ELS62 System Overview
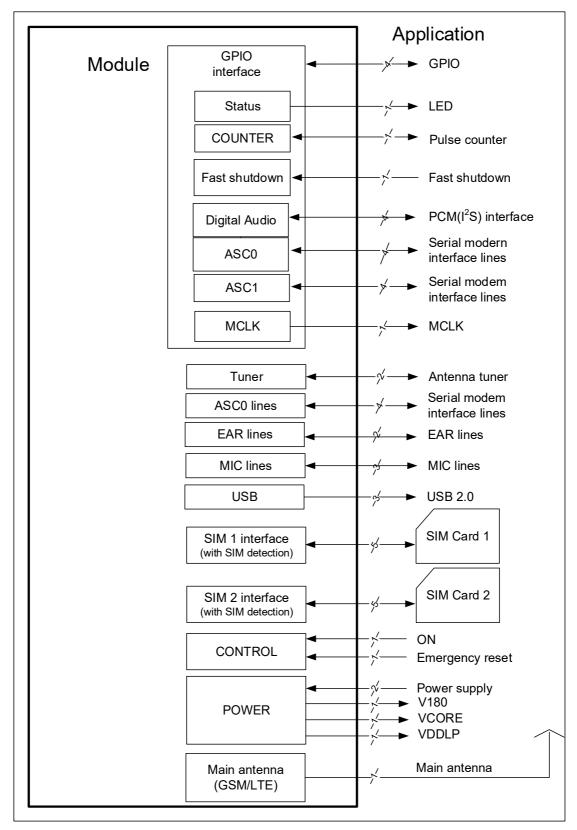
Figure 1: ELS62 system overview

1.4   Circuit Concept

Figure 2 and Figure 3 show block diagrams of the ELS62 module and illustrate the major functional components:
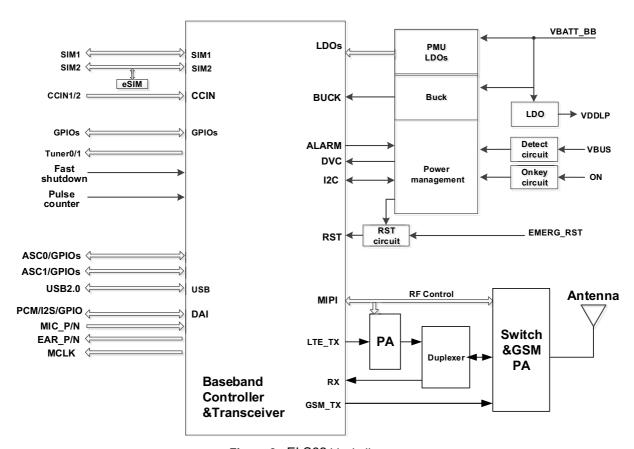
Figure 2: ELS62 block diagram

1.4 Circuit Concept
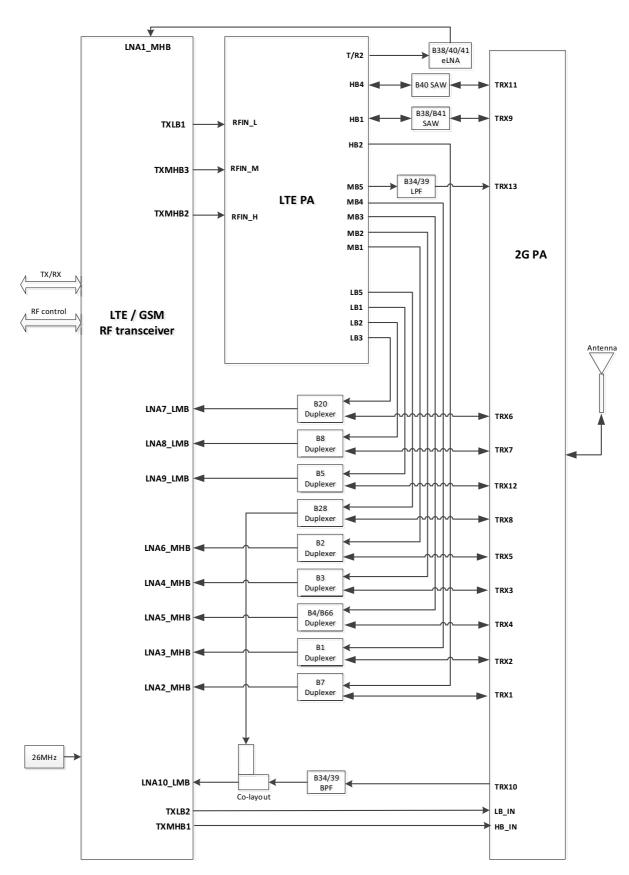
Figure 3: ELS62 RF section block diagram

2 Interface Characteristics

ELS62 is equipped with an SMT application interface that connects to the external application. The SMT application interface incorporates the various application interfaces as well as the RF antenna interface.

2.1 Application Interface

2.1.1 Pad Assignment

The SMT application interface on the ELS62 provides connecting pads to integrate the module into external applications. Figure 4 (bottom view) and Figure 5 (top view) show the connecting pads' numbering plan, the following Table 1 lists the pads' assignments.

Signal pads that are not used, i.e., marked as "rfu" (reserved for future use) or "nc" (not connected), need to be soldered, but should not have an electrical connection to the external application or GND. Also, pads marked as "rfu" are further qualified as either (dnu = do not use) or (<name>), indicating that they are either not used at all, or may be assigned to a named signal for a future product release.

Note: Thales strongly recommends to provide test points for certain signal lines to and from the module while developing SMT applications – for debug, test and/or trace purposes during the manufacturing process. In this way it is possible to detect soldering (and other) problems. Please refer to [4] for more information on test points and how to implement them. The signal lines for which test points should be provided for are marked as "Test point recommended" in Table 2.

Table 1: Pad assignments

Pad no.	Signal name	Pad no.	Signal name	Pad no.	Signal name
201	EARN	24	GPIO22/FSC	235	USB_DN[1]
202	EARP	25	GPIO21/DIN	236	nc
203	GND	26	GPIO23/BCLK	237	nc
204	BATT+$_{BB}$	27	rfu (dnu)	238	GND
205	GND	28	rfu (dnu)	239	GPIO5/LED
206	rfu (dnu)	29	GPIO17/TXD1[1]	240	GPIO6
207	ON	30	GPIO16/RXD1[1]	241	GPIO7
208	GND	31	GPIO18/RTS1[1]	242	GPIO8/COUNTER/ SIMSWITCH
209	V180[1]	32	GPIO19/CTS1[1]	53	BATT+$_{RF}$
210	RXD0[1]	33	EMERG_RST[1]	54	GND
211	CTS0[1]	221	GPIO12	55	GND
212	TXD0[1]	222	GPIO11	56	nc
213	GPIO23/RING0[1]	223	GND	57	GND
214	RTS0[1]	224	rfu (dnu)	58	GND
215	VDDLP[1]	225	GND	59	ANT_MAIN
216	CCRST1	226	nc	60	GND
217	CCIN1	227	GND	61	GND
218	CCIO1	228	nc	62	GND
219	rfu (dnu)[1]	229	GPIO4/FST_SHDN[1]	63	GND
220	GPIO13/MCLK[1]	230	GPIO3/DSR0[1]	64	AGND
20	CCVCC1	231	GPIO2/DCD0[1]	65	MIC_P
21	CCCLK1	232	GPIO1/DTR0[1]	66	MIC_N
22	VCORE[1]	233	VUSB[1]	243	VMIC
23	GPIO20/DOUT	234	USB_DP[1]	244	rfu (dnu)[1]
Centrally located pads					
67	rfu (dnu)	83	GND	99	GND
68	rfu (dnu)	84	GND	100	GND
69	rfu (dnu)	85	GND	101	GND
70	rfu (dnu)	86	GND	102	GND
71	nc	87	nc	103	GND
72	nc	88	GND	104	Tuner0
73	nc	89	GND	105	Tuner1
74	rfu (dnu)	90	GND	106	CCIN2
75	rfu (dnu)	91	nc	245	GND
76	rfu (dnu)	92	GND	246	CCVCC2
77	rfu (dnu)	93	GND	247	CCCLK2
78	rfu (dnu)	94	GND	248	CCIO2
79	nc	95	GND	249	CCRST2
80	rfu (dnu)[1]	96	GND	250	GND
81	GND	97	GND	251	GND
82	GND	98	GND	252	GND

1. Test point recommended.

Signal pads that are not used should not be connected to an external application.
Please note that the reference voltages listed in Table 2 are the values measured directly on the ELS62 module. They do not apply to the accessories connected.

2.1 Application Interface

240 GPIO6	239 GPIO5/LEDP	238 GND	237 nc	236 nc	235 USB_DN	234 USB_DP	233 VUSB	232 GPIO1/DTR0	231 GPIO2/DCD0	230 GPIO3/DSR0	229 GPIO4 FST_SHDN	228 nc	227 GND	226 nc	225 GND	224 nc	223 GND

Left column (top to bottom):
- 241 GPIO7
- 242 GPIO8/COUNTER/SIMSWITCH
- BATT+$_{RF}$
- 54 GND
- 55 GND
- 56 nc
- 57 GND
- 58 GND
- 59 ANT_MAIN
- 60 GND
- 61 GND
- 62 GND
- 63 GND
- 64 AGND
- 65 MIC_P
- 66 MIC_N
- 243 VMIC
- 244 rfu(dnu)

Right column (top to bottom):
- 222 GPIO11
- 221 GPIO12
- 33 EMERG_RST
- 32 GPIO19/CTS1
- 31 GPIO18/RTS1
- 30 GPIO16RXD1
- 29 GPIO17/TXD1
- 28 rfu(dnu)
- 27 rfu(dnu)
- 26 GPIO23/BCLK
- 25 GPIO21/DIN
- 24 GPIO22/FSC
- 23 GPIO20/DOUT
- 22 VCORE
- 21 CCCLK1
- 20 CCVCC1
- 219 rfu(dnu)

Center pad grid:

250 GND	100 GND	101 GND	102 GND	103 GND	104 Tuner0	105 Tuner1	106 CCIN2	249 CCRST2
251 GND	93 GND	94 GND	95 GND	96 GND	97 GND	98 GND	99 GND	248 CCIO2
89 GND	90 GND						91 nc	92 GND
85 GND	86 GND						87 nc	88 GND
81 GND	82 GND						83 GND	84 GND
252 GND	74 rfu(dnu)	75 rfu(dnu)	76 rfu(dnu)	77 rfu(dnu)	78 rfu(dnu)	79 nc	80 rfu(dnu)	247 CCCLK2
245 GND	N67 rfu(dnu)	68 rfu(dnu)	69 rfu(dnu)	70 rfu(dnu)	71 nc	72 nc	73 nc	246 CCVCC2

Position marker

Bottom row (left to right):

201 EARN	202 EARP	203 GND	204 BATT+BB	205 GND	206 rfu(dnu)	207 ON	208 GND	209 V180	210 RXD0	211 CTS0	212 TXD0	213 GPIO24/RING0	214 RTS0	215 VDDLP	216 CCRST1	217 CCIN1	218 CCIO1

Figure 4: ELS62 bottom view: Pad assignments

2.1 Application Interface

Figure 5: ELS62 top view: Pad assignments

2.1.2   Signal Properties

Table 2: Signal properties

Function	Signal name	IO	Signal form and level	Comment
Power supply	BATT+$_{BB}$ BATT+$_{RF}$	I	<u>GSM and LTE</u> $V_I$max = 4.5V $V_I$min = 3.0V during Tx burst on board GSM during Tx burst ___|¯¯¯|_____|¯¯¯|___ n Tx = n x 577µs peak current every 4.616ms	Lines of BATT+ and GND must be connected in parallel for supply purposes because higher peak currents may occur. Minimum voltage must not fall below 3.0 V including drop, ripple, spikes and not rise above 4.5V.
Power supply	GND		Ground	Application Ground
External supply voltage	V180	O	Normal operation: $V_O$norm = 1.80V ±3% $I_O$max = -10mA SLEEP mode Operation: V_OSleep = 1.80V ±5% $I_O$max = -10mA CLmax = 100µF	V180 should be used to supply level shifters at the interfaces or to supply external application circuits. VCORE and V180 may be used for the power indication circuit.
	VCORE	O	$V_O$norm = 1.2V ±2.5% $I_O$max = -10mA CLmax = 100nF SLEEP mode Operation: V_OSleep = 0.90V...1.2V ±4% $I_O$max = -10mA	Test point recommended.
	VDDLP	O	$V_O$norm=1.8V ±5% $I_O$max = -20mA $V_I$max =1.9V $V_I$min = 1.0V in power down mode	It is used for auto power-on circuit.It cannot power RTC when the module is power off. If unused keep line open. Test point recommended.
Ignition	ON[1]	I	V_{IH}max = 5V tolerant V_{IH}min = 1.3V V_{IL}max = 0.5V Slew rate ≤ 1ms ON ___|~~~~	This signal switches the module on, and is rising edge sensitive triggered. Test point recommended.

Table 2: Signal properties

Function	Signal name	IO	Signal form and level	Comment
Emergency reset	EMERG_RST	I	$R_I \approx 1k\Omega$, $C_I \approx 1nF$ V_{OH}max = V180 max V_{IH}min = 1.35V V_{IL}max = 0.3V at ~200µA ~~|___|~~ low impulse width > 10ms	This line must be driven low by an open drain or open collector driver connected to GND. If unused keep line open. Test point recommended.
Fast shutdown (TBD)	FST_SHDN[1]	I	V_{IL}max = 0.35V V_{IH}min = 1.30V V_{IH}max = 1.85V Imax = ±5mA ~~|___|~~ low impulse width > 1ms	This line must be driven low. Note that the fast shutdown line is originally available as GPIO line. If configured as fast shutdown, the GPIO line is assigned as follows: GPIO4 --> FST_SHDN If unused keep line open. Test point recommended
USB	VUSB_IN	I	$V_I$min = 3.5V $V_I$max = 5.15V Active and suspend current: I_{max} < 100µA	All electrical characteristics according to USB Implementers' Forum, USB 2.0 Specification. If unused keep lines open. Test point recommended.
	USB_DN	I/O	Full and high speed signal characteristics according USB 2.0 Specification.	
	USB_DP			
Serial Interface ASC0	RXD0	O	V_{OL}max = 0.25V at I = 1mA V_{OH}min = 1.55V at I = -1mA V_{OH}max = 1.85V	If unused keep lines open. Note that some ASC0 lines are originally available as GPIO lines. If configured as ASC0 lines, the GPIO lines are assigned as follows: GPIO1 --> DTR0 GPIO2 --> DCD0 GPIO3 --> DSR0 GPIO24 --> RING0 Test point recommended.
	CTS0	O		
	DSR0	O		
	DCD0	O		
	RING0	O		
	TXD0	I	V_{IL}max = 0.35V V_{IH}min = 1.30V V_{IH}max = 1.85V	
	RTS0	I	Pull down resistor active V_{IL}max = 0.35V V_{IH}min = 1.30V V_{IH}max = 1.85V	
	DTR0	I	Pull up resistor active V_{IL}max = 0.35V V_{IH}min = 1.30V V_{IH}max = 1.85V	

Table 2: Signal properties

Function	Signal name	IO	Signal form and level	Comment
Serial Interface ASC1	RXD1	O	$V_{OL}max = 0.25V$ at $I = 1mA$ $V_{OH}min = 1.55V$ at $I = -1mA$ $V_{OH}max = 1.85V$ $V_{IL}max = 0.35V$ $V_{IH}min = 1.30V$ $V_{IH}max = 1.85V$	If unused keep line open. Note that the ASC1 interface lines are originally available as GPIO lines. If configured as ASC1 lines, the GPIO lines are assigned as follows: GPIO16 --> RXD1 GPIO17 --> TXD1 GPIO18 --> RTS1 GPIO19 --> CTS1 Test point recommended.
	TXD1	I		
	RTS1	I		
	CTS1	O		
SIM card detection	CCIN1 CCIN2	I	$V_{IH}min = 1.30V$ $V_{IH}max = 1.85V$ $V_{IL}max = 0.35V$	CCIN = High, SIM card inserted. If unused keep line open.
3V SIM Card Interface	CCRST1 CCST2	O	$V_{OL}max = 0.45V$ at $I = 1mA$ $V_{OH}min = 2.35V$ at $I = -1mA$ $V_{OH}max = 3.10V$	Maximum cable length or copper track to SIM card holder should not exceed 100mm.
	CCIO1 CCIO2	I/O	$V_{IL}max = 0.75V$ $V_{IH}min = 2.05V$ $V_{IH}max = 3.10V$ $V_{OL}max = 0.45V$ at $I = 1mA$ $V_{OH}min = 2.35V$ at $I = 1mA$ $V_{OH}max = 3.10V$	
	CCCLK1 CCCLK2	O	$V_{OL}max = 0.45V$ at $I = 1mA$ $V_{OH}min = 2.35V$ at $I = -1mA$ $V_{OH}max = 3.10V$	
	CCVCC1 CCVCC2	O	$V_{O}min = 2.85V$ $V_{O}typ = 3.0V$ $V_{O}max = 3.15V$ $I_{O}max = -30mA$	

Table 2: Signal properties

Function	Signal name	IO	Signal form and level	Comment
1.8V SIM Card Inter-face	CCRST1 CCRST2	O	$V_{OL}max = 0.35V$ $V_{OH}min = 1.25V$ $V_{OH}max = 1.85V$	Maximum cable length or copper track to SIM card holder should not exceed 100mm.
	CCIO1 CCIO2	I/O	$V_{IL}max = 0.25V$ at I= 1mA $V_{IH}min = 1.50V$ at I= 1mA $V_{IH}max = 1.85V$	
	CCCLK1 CCCLK2	O	$V_{IL}max = 0.35$ $V_{IH}min = 1.25V$ $V_{IH}max = 1.85V$ $V_{OL}max = 0.25V$ at I = 1mA $V_{OH}min = 1.50V$ at I = -1mA $V_{OH}max = 1.85V$	
	CCVCC1 CCVCC2	O	$V_O min = 1.7V$ $V_O typ = 1.8V$ $V_O max = 1.9V$ $I_O max = -30mA$	
GPIO interface	GPIO1-GPIO8	IO	$V_{OL}max = 0.25V$ $V_{OH}min = 1.55V$ $V_{OH}max = 1.85V$ $V_{IL}max = 0.35V$ $V_{IH}min = 1.30V$ $V_{IH}max = 1.85V$ Imax = ±5mA	If unused keep line open. Please note that most GPIO lines can be config-ured by AT command for alternative functions: GPIO1-GPIO3: ASC0 control lines DTR0, DCD0 and DSR0 GPIO4: Fast shutdown, MCLK GPIO5: Status LED line GPIO8: Pulse Counter, SIM Switch GPIO13: MCLK[2] GPIO16-GPIO19: ASC1 or SPI GPIO20-GPIO23: PCM GPIO24: ASC0 control line RING0
	GPIO11-13	IO		
	GPIO16-24	IO		
Status LED	LED	O	$V_{OL}max = 0.25V$ $V_{OH}min = 1.55V$ $V_{OH}max = 1.85V$	If unused keep line open. Note that the LED line is originally available as GPIO line. If configured as LED line, the GPIO line is assigned as fol-lows: GPIO5 --> LED

Table 2: Signal properties

Function	Signal name	IO	Signal form and level	Comment
Pulse counter	COUNTER	I	Internal up resistor active $V_{IL}max = 0.35V$ $V_{IH}min = 1.30V$ $V_{IH}max = 1.85V$	If unused keep line open. Note that the COUNTER line is originally available as GPIO line. If configured as COUNTER line, the GPIO line is assigned as follows: GPIO8 --> COUNTER
Digital audio interface (DAI)	BCLK	O	$V_{OL}max = 0.25V$ at I=1mA $V_{OH}min = 1.55V$ at I=-1mA $V_{OH}max = 1.85V$	If unused keep line open. Note that the DAI interface lines are originally available as GPIO lines. If configured as DAI lines, the GPIO lines are assigned as follows: GPIO22 --> FSC GPIO23 --> BCLK GPIO20 --> DOUT GPIO21 --> DIN GPIO13 --> MCLK (Master clock out for external codecs)
	FSC	O		
	DOUT	O		
	DIN	I	$V_{IL}max = 0.35V$ $V_{IH}min = 1.30V$ $V_{IH}max = 1.85V$	
	MCLK	O	Fre=12.288MHz	
Analogue audio interface	VMIC	O	$V_O typ = 1.8V \pm 5\%$ Iomax = -2mA	Microphone supply for customer feeding circuits. If unused keep pin open.
	EARN EARP	O	Differential, max.37mW at 32 load C_{LOAD}<=400pF to AGND at each pin	Balanced output for earphone or balanced output for line out. If unused keep pin open.
	MIC_P MIC_N	I	Rimin = 5K Rimax = 10K $V_{IMAX}= 1.4$ Vpp	Balanced differential microphone with external feeding circuit (using VMIC and AGND) or balanced differential line input. Use coupling capacitors. If unused keep pins open
	AGND	O	Analog ground	GND level for external audio circuits.
Tuner0 Tuner1 Interface	ANT_SW	O	$V_{OL}max = 0.25V$ $V_{OH}min = 1.55V$ $V_{OH}max = 1.85V$	If unused keep line open.

1. Thales strongly recommends to provide test points for certain signal lines to and from the module while developing SMT application (for debug, test and/or trace purposes during the manufacturing process). In this way it is possible to detect soldering (and other) problems. The signal lines for which test points should be provided for are marked as "Test point recommended" in the above table.

2.1.2.1 Absolute Maximum Ratings

The absolute maximum ratings stated in Table 3 are stress ratings under any conditions. Stresses beyond any of these limits will cause permanent damage to ELS62.

Table 3: Absolute maximum ratings[1]
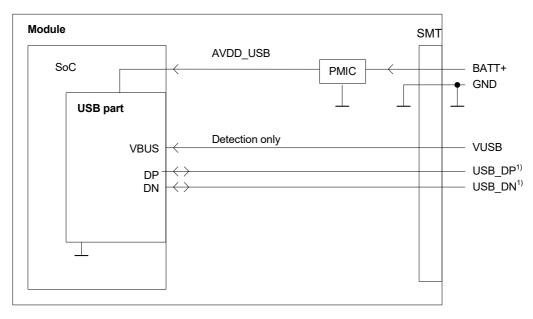
Parameter	Min	Max	Unit
Supply voltage BATT+$_{BB}$, BATT+$_{RF}$	-0.3	+5.5	V
Voltage at all signal lines in Power Down mode	-0.3	+0.3	V
Voltage at digital lines 1.8Vin normal operation	-0.2	V180 + 0.2	V
Current at digital lines in normal operation	-	+2	mA
Voltage at SIM interface, CCVCC 1.8V in normal operation	-0.3	+2	V
Voltage at SIM interface, CCVCC 3V in normal operation	-0.3	+3.3	V
Current at SIM interface in 1.8V and 3V operation	-	+50	mA
V180 in normal operation	+1.7	+1.9	V
Current at V180 in normal operation	-	+50	mA
VCORE in normal operation	+0.8	+1.32	V
Current at VCORE in normal operation	-	+50	mA
VDDLP in normal operation	-0.15	+2	V
Current at VDDLP in normal operation	-	+50	mA

1. Positive noted current means current sourcing from ELS62. Negative noted current means current sourcing towards ELS62.

2.1.3   USB Interface

ELS62 supports a USB 2.0 High Speed (480Mbit/s) device interface that is Full Speed (12Mbit/s) compliant. The USB interface is primarily intended for use as command and data interface and for downloading firmware.

The external application is responsible for supplying the VUSB_IN line. This line is used for cable detection only. The USB part (driver and transceiver) is supplied by means of BATT+. This is because ELS62 is designed as a self-powered device compliant with the "Universal Serial Bus Specification Revision 2.0"[1].

[1] If the USB interface is operated in High Speed mode (480MHz), it is recommended to take special care routing the data lines USB_DP and USB_DN. Application layout should in this case implement a differential impedance of 90 ohms for proper signal integrity.

Figure 6: USB circuit

To properly connect the module's USB interface to the external application, a USB 2.0 compatible connector and cable or hardware design is required. For more information on the USB related signals see Table 2. Furthermore, the USB modem driver distributed with ELS62 needs to be installed.

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1. The specification is ready for download on http://www.usb.org/developers/docs/

2.1.4   Serial Interface ASC0

ELS62 offers an 8-wire unbalanced, asynchronous modem interface ASC0 conforming to ITU-T V.24 protocol DCE signaling. The electrical characteristics do not comply with ITU-T V.28. The significant levels are 0V (for low data bit or active state) and 1.8V (for high data bit or inactive state). For electrical characteristics please refer to Table 2. For an illustration of the interface line's startup behavior see Figure 7.

ELS62 is designed for use as a DCE. Based on the conventions for DCE-DTE connections it communicates with the customer application (DTE) using the following signals:
• Port TXD @ application sends data to the module's TXD0 signal line
• Port RXD @ application receives data from the module's RXD0 signal line
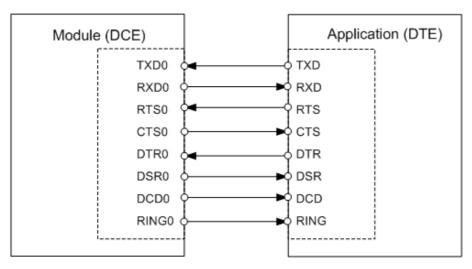
Figure 7: Serial interface ASC0

Features:
• Includes the data lines TXD0 and RXD0, the status lines RTS0 and CTS0 and, in addition, the modem control lines DTR0(TBD), DSR0(TBD), DCD0(TBD) and RING0.
• The RING0 signal serves to indicate incoming calls and other types of URCs (Unsolicited Result Code). It can also be used to send pulses to the host application, for example to wake up the application from power saving state.
• Configured for 8 data bits, no parity and 1 stop bit.
• ASC0 can be operated at fixed bit rates from 300bps up to 921,600bps.
• Autobauding supports bit rates from 1,200bps up to 230,400bps.
• Supports RTS0/CTS0 hardware flow control. The hardware hand shake line RTS0 has an internal pull down resistor causing a low level signal, if the line is not used and open. Although hardware flow control is recommended, this allows communication by using only RXD and TXD lines.
• Wake up from SLEEP mode by RTS0 activation (high to low transition; see Section 3.3.3).

Note: The ASC0 modem control lines DTR0, DCD0, DSR0 and RING0 are originally available as GPIO lines. If configured as ASC0 lines, these GPIO lines are assigned as follows: GPIO1 --> DTR0, GPIO2 --> DCD0, GPIO3 --> DSR0 and GPIO24 --> RING0. (TBD)

Note: It is recommended to select UART cables supported high bit rate.

2.1.5   Serial Interface ASC1

Four ELS62 GPIO lines can be configured as ASC1 interface signals to provide a 4-wire un-balanced, asynchronous modem interface ASC1 conforming to ITU-T V.24 protocol DCE signaling. The electrical characteristics do not comply with ITU-T V.28. The significant levels are 0V (for low data bit or active state) and 1.8V (for high data bit or inactive state). For electrical characteristics please refer to Table 2. For an illustration of the interface line's startup behavior see Figure 10.

The ASC1 interface lines are originally available as GPIO lines. If configured as ASC1 lines, the GPIO lines are assigned as follows: GPIO16 --> RXD1, GPIO17 --> TXD1, GPIO18 --> RTS1 and GPIO19 --> CTS1. Configuration is done by AT command (see [1]: AT^SCFG). The configuration is non-volatile and becomes active after a module restart.

ELS62 is designed for use as a DCE. Based on the conventions for DCE-DTE connections it communicates with the customer application (DTE) using the following signals:
- Port TXD @ application sends data to module's TXD1 signal line
- Port RXD @ application receives data from the module's RXD1 signal line
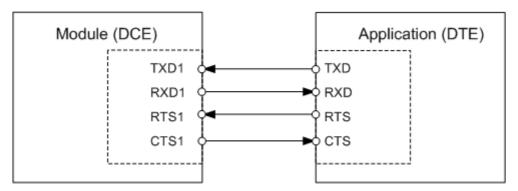
Figure 8: Serial interface ASC1

Features
- Includes only the data lines TXD1 and RXD1 plus RTS1 and CTS1 for hardware handshake.
- On ASC1 no RING line is available.
- Configured for 8 data bits, no parity and 1 or 2 stop bits.
- ASC1 can be operated at fixed bit rates from 300bps to 921,600 bps.
- Autobauding supports bit rates from 1,200bps up to 230,400bps.
- Supports RTS1/CTS1 hardware flow. The hardware hand shake line RTS0 has an internal pull down resistor causing a low level signal, if the line is not used and open. Although hardware flow control is recommended, this allows communication by using only RXD and TXD lines.

Note: It is recommended to select UART cables supported high bit rate.

2.1.6   UICC/SIM/USIM Interface

ELS62 has an integrated UICC/SIM/USIM interface compatible with the 3GPP 31.102 and ETSI 102 221. This is wired to the host interface in order to be connected to an external SIM card holder. Five pads on the SMT application interface are reserved for the SIM interface.

The UICC/SIM/USIM interface supports 3V and 1.8V SIM cards. Please refer to Table 2 for electrical specifications of the UICC/SIM/USIM interface lines depending on whether a 3V or 1.8V SIM card is used.

The CCIN signal serves to detect whether a tray (with SIM card) is present in the card holder. To take advantage of this feature, an appropriate SIM card detect switch is required on the card holder. For example, this is true for the model supplied by Molex, which has been tested to operate with ELS62 and is part of the Thales reference equipment submitted for type approval. See Section 7.1 for Molex ordering numbers.

Table 4: Signals of the SIM interface (SMT application interface)

Signal	Description
GND	Separate ground connection for SIM card to improve EMC.
CCCLK1 CCCLK2	Chipcard clock lines for 1st and 2nd SIM interface.
CCVCC1 CCVCC2	SIM supply voltage lines for 1st and 2nd SIM interface.
CCIO1 CCIO2	Serial data line for 1st and 2nd SIM interface, input and output.
CCRST1 CCRST2	Chipcard reset lines for 1st and 2nd SIM interface.
CCIN1 CCIN2	Input on the baseband processor for detecting a SIM card tray in the holder. If the SIM is removed during operation the SIM interface is shut down immediately to prevent destruction of the SIM. The CCIN signal is by default low and will change to high level if a SIM card is inserted. The CCIN signal is mandatory for applications that allow the user to remove the SIM card during operation. The CCIN signal is solely intended for use with a SIM card. It must not be used for any other purposes. Failure to comply with this requirement may invalidate the type approval of ELS62.

Note [1]: No guarantee can be given, nor any liability accepted, if loss of data is encountered after removing the SIM card during operation. Also, no guarantee can be given for properly initializing any SIM card that the user inserts after having removed the SIM card during operation. In this case, the application must restart ELS62.

The figure below shows a circuit to connect an external SIM card holder.

* = Optional 10pF for SIM protection against RF (internal antenna)
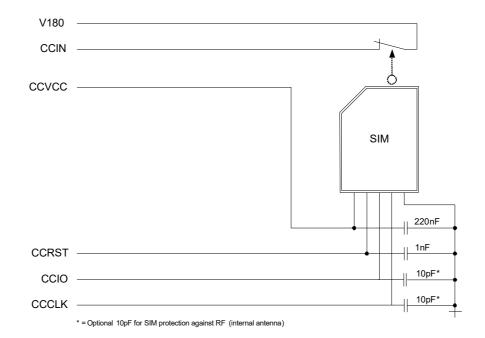
Figure 9: External UICC/SIM/USIM card holder circuit

The total cable length between the SMT application interface pads on ELS62 and the pads of the external SIM card holder must not exceed 100mm in order to meet the specifications of 3GPP TS 51.010-1 and to satisfy the requirements of EMC compliance.

To avoid possible cross-talk from the CCCLK signal to the CCIO signal be careful that both lines are not placed closely next to each other. A useful approach is using a GND line to shield the CCIO line from the CCCLK line.

An example for an optimized ESD protection for the SIM interface is shown in Section 2.1.6.1.

2.1.6.1   Enhanced ESD Protection for SIM Interface

To optimize ESD protection for the SIM interface it is possible to add ESD diodes to the SIM interface lines as shown in the example given in Figure 10.[1]

The example was designed to meet ESD protection according ETSI EN 301 489-1/52: Contact discharge: ± 4kV, air discharge: ± 8kV.
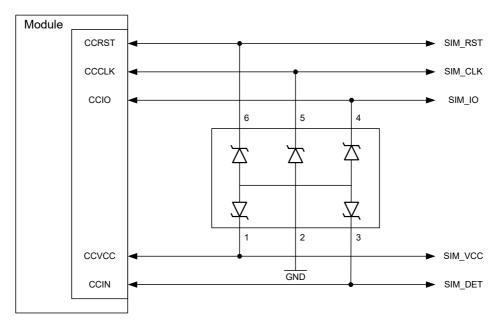
Figure 10: SIM interface - enhanced ESD protection

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1. Note that the protection diode shall have low internal capacitance less than 5pF for IO and CLK.

2.1.7   Digital Audio Interface (DAI)

ELS62 supports a digital audio interface that can be employed either as pulse code modulation interface (see Section 2.1.7.1) or as inter IC sound interface (see Section 2.1.7.2).

2.1.7.1   Pulse Code Modulation Interface (PCM)

Four ELS62 GPIO lines can be configured as pule code modulation interface (PCM). The PCM functionality allows for the use of an external codec like the NAU8822A (see Section 2.1.7.3).

The PCM interface supports the following features:
*   Master mode
*   Long frame and short frame
*   16kHz/8kHz sample rate
*   512,1024 and 4096kHz bit clock at 16kHz sample rate
*   256kHz, 512kHz and 2048kHz bit clock at 8kHz sample rate

The four GPIO lines can be configured as DAI/PCM interface signals as follows: GPIO20 --> DOUT, GPIO21--> DIN, GPIO22 --> FSC and GPIO23 --> BCLK. The configuration is done by AT command (see [1]). It is non-volatile and becomes active after a module restart. Table 5 describes the available DAI/PCM lines at the digital audio interface. For electrical details see Section 2.1.2.

Table 5: Overview of DAI/PCM lines

Signal name	Input/Output	Description
DOUT	O	PCM data from ELS62 to external codec.
DIN	I	PCM data from external codec to ELS62.
FSC	O	Frame synchronization signal to external codec: Long frame (8kHz/16kHz)
BCLK	O	Bit clock to external codec.
MCLK	-	Optional master clock out to supply external codec.

Figure 12 and Figure 12 shows the PCM timing for the master mode available with ELS62.
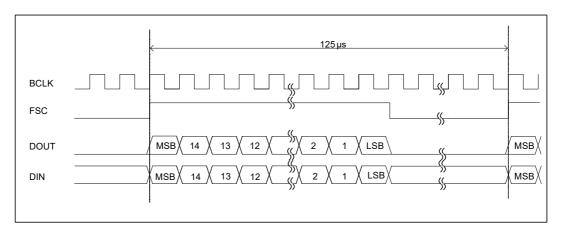
Figure 11: Long frame PCM timing, 8kHz
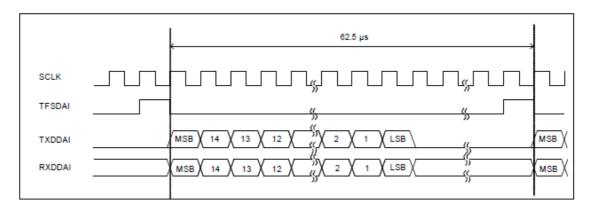
Figure 12: Short frame PCM timing, 16kHz

2.1.7.2   Inter IC Sound Interface

The Inter IC Sound interface (I^2S) is enabled using the AT command AT^SAIC (see [1]). An activation is possible only out of call and out of tone presentation. The I^2S properties and capabilities comply with the requirements laid out in the Phillips I^2S Bus Specifications, revised June 5, 1996.

The I^2S interface has the following characteristics:

• Clock Modes: Master with permanent clock option
• Sampling Rate: 8kHz (narrow band), 16kHz (wide band)
• Bit clock: 256kHz (sample rate: 8kHz), 512kHz (sample rate:16kHz)

The digital audio interface pads available for the PCM interface are also available for the I^2S interface. In I^2S mode they have the same electrical characteristics (for more information on the DOUT, DIN, FSC, and BCLK pads please refer to Section 2.1.2 and Section 2.1.7.1).

The table below lists the available pads at the module's digital audio interface.

Table 6: Overview of DAI/I^2S lines

Signal name	Input/Output	Description
DOUT	O	I^2S data from module to external codec.
DIN	I	I^2S data from external codec to module.
FSC	O	Frame synchronization signal to external codec: Word alignment (WS)
BCLK	O	Bit clock to external codec: 256kHz/512kHz
MCLK	O	Optional master clock out to supply external codecs.

The following figure shows the I^2S timing for the master mode available with the module.
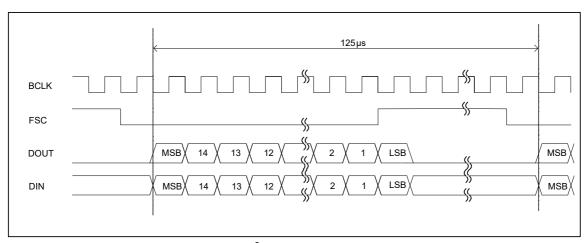
Figure 13: I^2S timing, 8kHz sample rate

2.1.7.3   Solutions for the Digital Audio Interface

There is an examples of using the digital audio interface of the module below.

The sample is Nuvoton codec NAU8822A which can be replaced with a DSP. Thus the slave mode codec chip runs synchronously to the network.
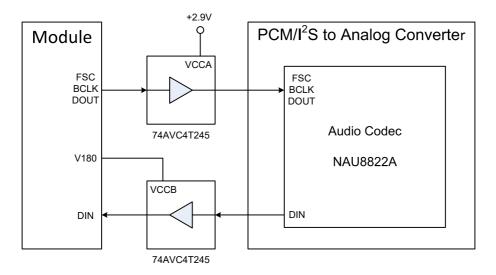
Figure 14: Block circuit connection for module's DAI interface to codec chip NAU8822A

The Nuvoton Codec NAU8822A is controlled via I²C interface. The module is set to master for the framesync and the clock.

If module works in master PCM mode, this can be done via the following AT command: AT^SAIC=1,1,1,3,0,0,1,0,0

Correspondingly, the related codec register settings are presented below:

Table 7: Codec register settings

Register	Setting
Audio interface	NAUregister[4]=0x010
Clock Control	NAUregister[6]=0x004
Audio Sample Rate Control	NAUregister[7]=0x006

2.1.8   Analog Audio Interface

ELS62 has an analog audio interface with a balanced analog microphone input and a balanced analog earpieces output. A supply voltage and an analog ground connection are provided at dedicated pads.

2.1.8.1   Microphone Inputs and Supply

A regulated power supply for electric microphones is available at VMIC. The voltage at VMIC is rated at 1.8V at 2mA and is available while audio is active (e.g. during a call).

The following figures show possible microphone and line connections.
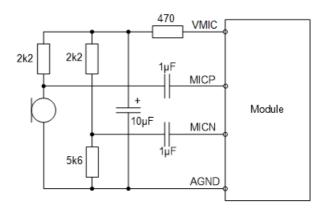
Figure 15: Single ended microphone connection

The above configuration is suitable for short connections between microphone and the module. A typical electric microphone has a metal case connected to its ground pad. Since this is routed directly to AGND, electro static discharges applied to the microphone will be easily led away. It is recommended to use an additional RC-filter for VMIC (for example 470 Ohm and 10μF as shown in the figure) if a high microphone gain is necessary.
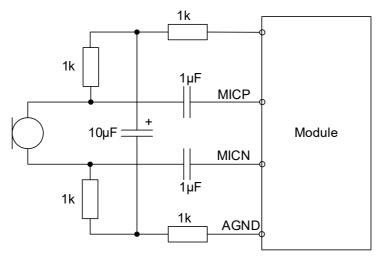
Figure 16: Differential microphone connection

If the microphone lines are long, use the above configuration. It is recommended to use an additional RC-filter for VMIC (for example 1kOhm, 10μF and 1kOhm as shown in the figure) if a high microphone gain is necessary.
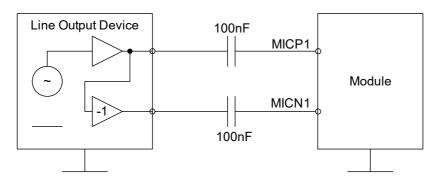
Figure 17: Line input

Using the line input configuration the output level of the ground related balanced source should be as high as possible to achieve the best SNR.

2.1.8.2   Loudspeaker Output

ELS62 provides a differential loudspeaker output EARP/EARN. If the output is used as line output, the application should provide a capacitor decoupled differential input to eliminate GSM humming. A single ended connection to a speaker or a line input is strongly not recommended.

The following figures show the typical output configurations.
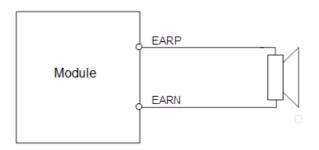
Figure 18: Differential loudspeaker connection
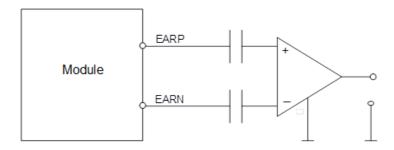
Figure 19: Line output connection

2.1.8.3 Electrical Characteristics of the Voiceband Part

Setting Audio Parameters by AT Commands
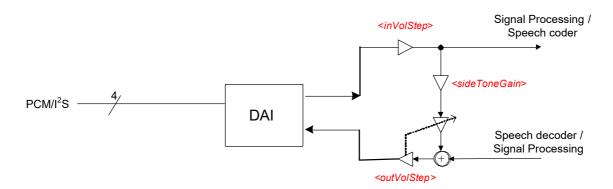
The audio modes for ELS62 can be adjusted according to the AT command parameter listed in the table below. Each audio mode is assigned a separate set of parameters.

Table 8: Audio parameters adjustable by AT command

Parameter	Influence to	Range	Gain range	Calculation
AT^SNFI				
inVolStep	Digital TX Gain	0 1...48	Mute -36…+12dB	1dB steps
inpgaStep	Codec Tx Gain	0 1...4	Mute -36…+24dB	6dB steps
AT^SNFO				
outVolStep	Digital RX Gain	0 1...48	Mute -36…+12dB	1dB steps
dacGain	Codec Rx Gain	0 1...4	Mute -6...+6dB	3dB steps

Audio Programming Model

The audio programming model shows how the signal path can be influenced by varying AT command parameters: . For more information on the AT commands and parameters see Section and [1].

Figure 20: Audio programming model (TBD)

Characteristics of Audio Modes

The electrical characteristics of the voiceband part depend on the current audio mode set with AT command. All values are noted for default gains, e.g. the default parameters are left unchanged.

Note: With regard to acoustic shock, the cellular application must be designed to avoid sending false AT commands that might increase amplification, e.g. for a highly sensitive earpiece. A protection circuit should be implemented in the cellular application.

2.1.9   GPIO Interface

ELS62 offers a GPIO interface with 22 GPIO lines. The GPIO lines are shared with other interfaces or functions: Fast shutdown (see Section 2.1.11.4), status LED (see Section 2.1.11.1), an pulse counter (see Section 2.1.10), ASC0 (see Section 2.1.4), ASC1 (see Section 2.1.5), an and a DAI interface (see Section 2.1.7).

The following table shows the configuration variants for the GPIO pads. All variants are mutually exclusive, i.e. a pad configured for instance as Status LED is locked for alternative usage.

Table 9: GPIO lines and possible alternative assignment

GPIO	Fast Shutdown	Status LED	Pulse Counter	SIM SWITCH	ASC0	ASC1	DAI
GPIO1					DTR0		
GPIO2					DCD0		
GPIO3					DSR0		
GPIO4	FST_SHDN						
GPIO5		Status LED					
GPIO6							
GPIO7							
GPIO8			COUNTER	SIM SWITCH			
GPIO11							
GPIO12							
GPIO13							MCLK
GPIO16						RXD1	
GPIO17						TXD1	
GPIO18						RTS1	
GPIO19						CTS1	
GPIO20							DOUT
GPIO21							DIN
GPIO22							FSC
GPIO23							BCLK
GPIO24					RING0		

After startup, the above mentioned alternative GPIO line assignments can be configured using AT commands (see [1]). The configuration is non-volatile and available after module restart.

2.1.10 Pulse Counter

The GPIO8 line can be configured as pulse counter line COUNTER. The pulse counter interface can be used, for example, as a clock (for GPIOs see Section 2.1.9).

2.1.11 Control Signals

2.1.11.1 Status LED

The GPIO5 interface line can be configured to drive a status LED that indicates different operating modes of the module (for GPIOs see Section 2.1.9). GPIO and LED functionality are mutually exclusive.

To take advantage of this function connect an LED to the GPIO5/LED line as shown in Figure 21.
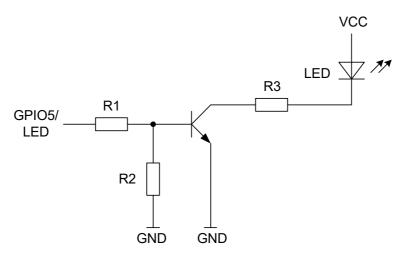
Figure 21: Status signaling with LED driver

2.1.11.2   Power Indication Circuit

In Power Down mode the maximum voltage at any digital or analog interface line must not exceed +0.3V (see also Section 2.1.2.1). Exceeding this limit for any length of time might cause permanent damage to the module.

It is therefore recommended to implement a power indication signal that reports the module's power state and shows whether it is active or in Power Down mode. While the module is in Power Down mode all signals with a high level from an external application need to be set to low state or high impedance state. The sample power indication circuit illustrated in Figure 22 denotes the module's active state with a low signal and the module's Power Down mode with a high signal or high impedance state.
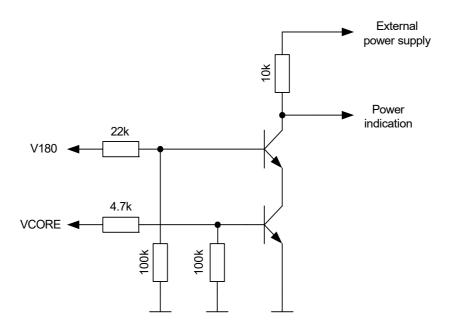
Figure 22: Power indication circuit

2.1.11.3   Host Wakeup

If no call, data or message transfer is in progress, the host may shut down its own USB interface to save power. If a call or other request (URC's, messages) arrives, the host can be notified of these events and be woken up again by a state transition of the ASC0 interface's RING0 line. This functionality should only be used with legacy USB applications not supporting the recommended USB suspend and resume mechanism as described in [5] (see also Section 2.1.3.1). For more information on how to configure the RING0 line by AT^SCFG command see [1].

Possible RING0 line states are listed in Table 10.

Table 10: Host wakeup lines

Signal	I/O	Description
RING0	O	Inactive to active low transition: 0 = The host shall wake up 1 = No wake up request

2.1.11.4 Fast Shutdown (TBD)

The GPIO4 interface line can be configured as fast shutdown signal line FST_SHDN. The configured FST_SHDN line is an active low control signal and must be applied for at least 1 milliseconds. If unused this line can be left open because of a configured internal pull-up resistor.

The fast shutdown feature can be triggered using the AT command AT^SMSO=<fso>. For details see [1].

If triggered, a low impulse >1 milliseconds on the FST_SHDN line starts the fast shutdown. The fast shutdown procedure still finishes any data activities on the module's flash file system, thus ensuring data integrity, but will no longer deregister gracefully from the network, thus saving the time required for network deregistration.
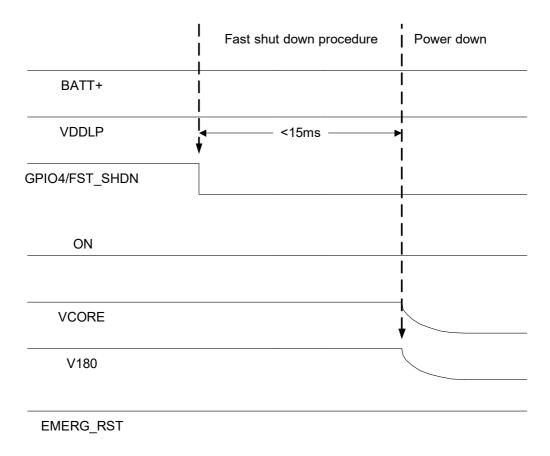
Figure 23: Fast shutdown timing

Please note that the normal software controlled shutdown using AT^SMSO will allow option for a fast shutdown by parameter <fso>, i.e., without network deregistration. However, in this case no URCs including shutdown URCs will be provided by the AT^SMSO command.
Please also note that the fast shutdown operation does not allow the module deregister from the network, therefore, this practice is not recommended, and should not be conducted on regular basis. If it is used for energy saving reason, for instance, used in battery-driven solutions that require prompt system shutdown before battery depletion, discretion is advised in such case.

2.2   RF Antenna Interface

The ELS62 GSM/LTE antenna interface comprises a GSM/LTE antenna . The RF interface has an impedance of 50Ω.

The external antenna must be matched properly to achieve best performance regarding radiated power, modulation accuracy and harmonic suppression. Antenna matching networks are not included on the ELS62 module and should be placed in the host application if the antenna does not have an impedance of 50Ω.

Regarding the return loss ELS62 provides the following values in the active band:

Table 11: Return loss in the active band

State of module	Return loss of module	Recommended return loss of application
Receive	≥ 8dB	≥ 12dB
Transmit	Not applicable	≥ 12dB
Idle	≤ 5dB	Not applicable

2.2.1   Antenna Interface Specifications.

Table 12: RF Antenna interface GSM/LTE (at operating temperature range)

Parameter	Conditions	Min.	Typical	Max.	Unit
LTE connectivity	Band 1, 2, 3, 4, 5, 7, 8, 20, 28, 34, 38, 39, 40, 41, 66				
Receiver Input Sensitivity @ ARP (channel. bandwidth 5MHz) Typical @25°C 3.8V	LTE 2100 Band 1		TBD		dBm
	LTE 1900 Band 2		TBD		dBm
	LTE 1800 Band 3		TBD		dBm
	LTE 2100 Band 4		TBD		dBm
	LTE 850 Band 5		TBD		dBm
	LTE 2600 Band 7		TBD		dBm
	LTE 900 Band 8		TBD		dBm
	LTE 800 Band 20		TBD		dBm
	LTE 700 Band 28		TBD		dBm
	LTE 2000 Band 34		TBD		dBm
	LTE 2600 Band 38		TBD		dBm
	LTE 1900 Band 39		TBD		dBm
	LTE 2300 Band 40		TBD		dBm
	LTE 2500 Band 41		TBD		dBm
	LTE 2100 Band 66		TBD		dBm
LTE Maximum TX power	LTE 2100 Band 1	TBD	+23.0		dBm
	LTE 1900 Band 2	TBD	+23.0		dBm
	LTE 1800 Band 3	TBD	+23.0		dBm
	LTE 2100 Band 4	TBD	+23.0		dBm
	LTE 850 Band 5	TBD	+23.0		dBm
	LTE 2600 Band 7	TBD	+23.0		dBm
	LTE 900 Band 8	TBD	+23.0		dBm
	LTE 800 Band 20	TBD	+23.0		dBm
	LTE 700 Band 28	TBD	+23.0		dBm
	LTE 2000 Band 34	TBD	+23.0		dBm
	LTE 2600 Band 38	TBD	+23.0		dBm
	LTE 1900 Band 39	TBD	+23.0		dBm
	LTE 2300 Band 40	TBD	+23.0		dBm
	LTE 2500 Band 41	TBD	+23.0		dBm
	LTE 2100 Band 66	TBD	+23.0		dBm
GPRS coding schemes	Class 12, CS1 to CS4				
EGPRS	Class 12, MCS1 to MCS9				

Table 12: RF Antenna interface GSM/LTE (at operating temperature range)

Parameter		Conditions	Min.	Typical	Max.	Unit
Static Receiver input Sensitivity @ ARP		GSM 850	-102			dBm
		E-GSM 900	-102			dBm
		DCS 1800	-102			dBm
		PCS 1900	-102			dBm
RF Power @ ARP with 50Ω Load	GSM	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm

Table 12: RF Antenna interface GSM/LTE (at operating temperature range)

Parameter		Conditions	Min.	Typical	Max.	Unit
RF Power @ ARP with 50Ω Load, (**ROPR = 0**, i.e. no reduction)	GPRS, 1 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	EDGE, 1 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	GPRS, 2 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	EDGE, 2 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	GPRS, 3 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	EDGE, 3 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	GPRS, 4 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	EDGE, 4 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm

Table 12: RF Antenna interface GSM/LTE (at operating temperature range)

Parameter		Conditions	Min.	Typical	Max.	Unit
RF Power @ ARP with 50Ω Load, (**ROPR = 1**)	GPRS, 1 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	EDGE, 1 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	GPRS, 2 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	EDGE, 2 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	GPRS, 3 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	EDGE, 3 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	GPRS, 4 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	EDGE, 4 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm

Table 12: RF Antenna interface GSM/LTE (at operating temperature range)

Parameter		Conditions	Min.	Typical	Max.	Unit
RF Power @ ARP with 50Ω Load, (**ROPR = 2**)	GPRS, 1 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	EDGE, 1 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	GPRS, 2 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	EDGE, 2 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	GPRS, 3 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	EDGE, 3 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	GPRS, 4 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	EDGE, 4 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm

Table 12: RF Antenna interface GSM/LTE (at operating temperature range)

Parameter		Conditions	Min.	Typical	Max.	Unit
RF Power @ ARP with 50Ω Load, (**ROPR = 3**)	GPRS, 1 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	EDGE, 1 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	GPRS, 2 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	EDGE, 2 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	GPRS, 3 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	EDGE, 3 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	GPRS, 4 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	EDGE, 4 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm

Table 12: RF Antenna interface GSM/LTE (at operating temperature range)

Parameter		Conditions	Min.	Typical	Max.	Unit
RF Power @ ARP with 50Ω Load, (**ROPR = 4**, i.e. maximum reduction)	GPRS, 1 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	EDGE, 1 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	GPRS, 2 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	EDGE, 2 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	GPRS, 3 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	EDGE, 3 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	GPRS, 4 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm
	EDGE, 4 TX	GSM 850		TBD		dBm
		E-GSM 900		TBD		dBm
		DCS 1800		TBD		dBm
		PCS 1900		TBD		dBm

2.2.2 Antenna Installation

The antenna is connected by soldering the antenna pad (ANT_MAIN) and its neighboring ground pads (GND) directly to the application's PCB. The antenna pads are the antenna reference points (ARP) for ELS62. All RF data specified throughout this document is related to the ARP.
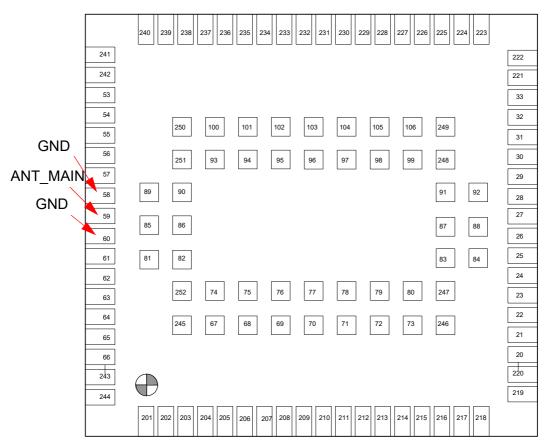
Figure 24: Antenna pads (bottom view)

The distance between the antenna pad and its neighboring GND pads has been optimized for best possible impedance. To prevent mismatch, special attention should be paid to these pads on the application's PCB.

The wiring of the antenna connection, starting from the antenna pad to the application's antenna should result in a 50Ω line impedance. Line width and distance to the GND plane needs to be optimized with regard to the PCB's layer stack. Some examples are given in Section 2.2.3.

To prevent receiver desensitization due to interferences generated by fast transients like high speed clocks on the external application PCB, it is recommended to realize the antenna connection line using embedded Stripline rather than Micro-Stripline technology. Please see Section 2.2.3.1 for examples of how to design the antenna connection in order to achieve the required 50Ω line impedance.

For type approval purposes, the use of a 50Ω coaxial antenna connector (U.FL-R-SMT) might be necessary. In this case the U.FL-R-SMT connector should be placed as close as possible to ELS62's antenna pad.

2.2.3 RF Line Routing Design

2.2.3.1 Line Arrangement Examples

Several dedicated tools are available to calculate line arrangements for specific applications and PCB materials - for example from http://www.polarinstruments.com/ (commercial software) or from https://www.awr.com/awr-software/options/tx-line or https://saturnpcb.com/saturn-pcb-toolkit/ (free software).

Embedded Stripline

This figure below shows a line arrangement example for embedded stripline with 65µm FR4 prepreg (type: 1080) and 710µm FR4 core (4-layer PCB).
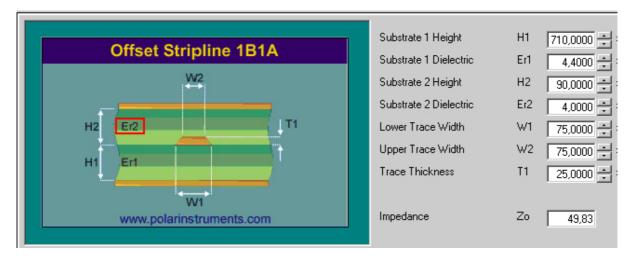
Figure 25: Embedded Stripline with 65µm prepreg (1080) and 710µm core

Micro-Stripline

This section gives two line arrangement examples for micro-stripline.

- Micro-Stripline on 1.0mm Standard FR4 2-Layer PCB
  The following two figures show examples with different values for D1 (ground strip separation).

Substrate 1 Height	H1	1000,000
Substrate 1 Dielectric	Er1	4,4000
Lower Trace Width	W1	800,0000
Upper Trace Width	W2	800,0000
Ground Strip Separation	D1	185,0000
Trace Thickness	T1	25,0000
Coating Above Substrate	C1	15,0000
Coating Above Trace	C2	15,0000
Coating Dielectric	CEr	4,0000
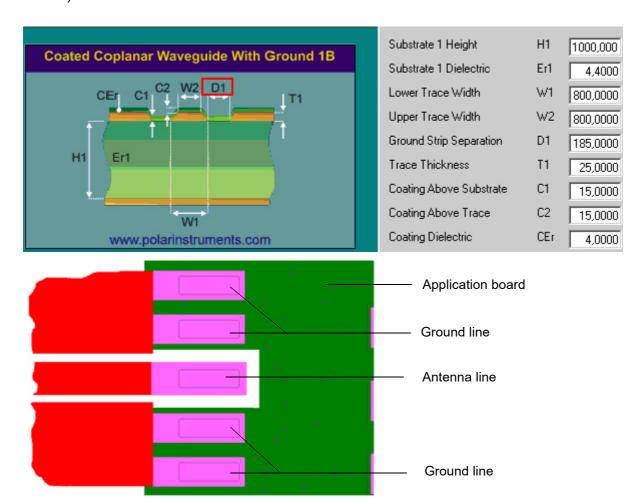
Figure 26: Micro-Stripline on 1.0mm standard FR4 2-layer PCB - example 1

Substrate 1 Height	H1	1000,000
Substrate 1 Dielectric	Er1	4,4000
Lower Trace Width	W1	1050,000
Upper Trace Width	W2	1050,000
Ground Strip Separation	D1	275,0000
Trace Thickness	T1	25,0000
Coating Above Substrate	C1	15,0000
Coating Above Trace	C2	15,0000
Coating Dielectric	CEr	4,0000

Application board

Ground line

Antenna line

Ground line
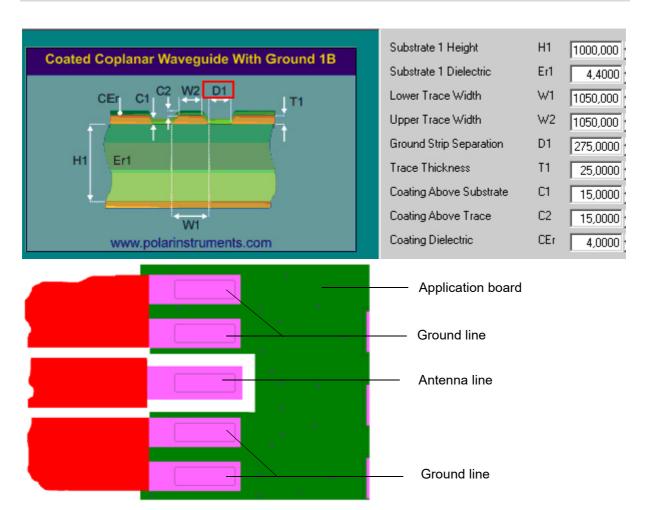
Figure 27: Micro-Stripline on 1.0mm Standard FR4 PCB - example 2

- Micro-Stripline on 1.5mm Standard FR4 2-Layer PCB
The following two figures show examples with different values for D1 (ground strip separation).

Substrate 1 Height	H1	1500,000
Substrate 1 Dielectric	Er1	4,4000
Lower Trace Width	W1	800,0000
Upper Trace Width	W2	800,0000
Ground Strip Separation	D1	165,0000
Trace Thickness	T1	25,0000
Coating Above Substrate	C1	15,0000
Coating Above Trace	C2	15,0000
Coating Dielectric	CEr	4,0000
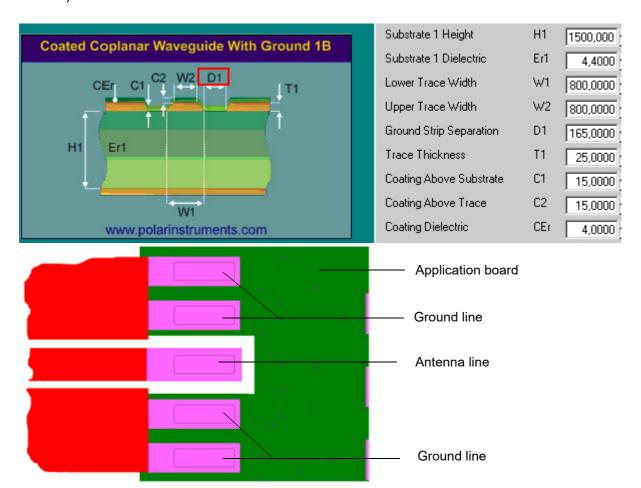
Figure 28: Micro-Stripline on 1.5mm Standard FR4 PCB - example 1

Substrate 1 Height	H1	1500,000
Substrate 1 Dielectric	Er1	4,4000
Lower Trace Width	W1	1150,000
Upper Trace Width	W2	1150,000
Ground Strip Separation	D1	225,0000
Trace Thickness	T1	25,0000
Coating Above Substrate	C1	15,0000
Coating Above Trace	C2	15,0000
Coating Dielectric	CEr	4,0000
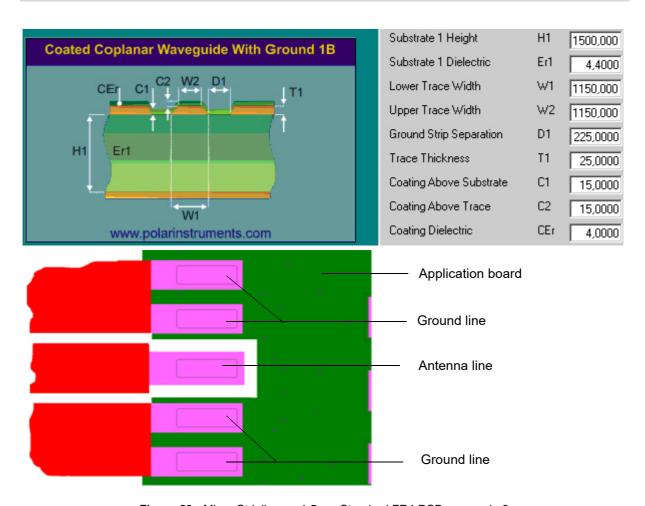
Figure 29: Micro-Stripline on 1.5mm Standard FR4 PCB - example 2

2.2.3.2   Routing Example

Interface to RF Connector

Figure 30 and Figure 31 show a sample connection of the module's antenna pad at the bottom layer of the module PCB with an application PCB's coaxial antenna connector. Line impedance depends on line width, but also on other PCB characteristics like dielectric, height and layer gap. The sample line width of 0.26mm and the spaces of 0.2mm are only recommended for an application with a PCB layer stack resembling the one of the ELS62 evaluation board, and with layer 5 cut clear(Bottom layer reference to Layer 4). For different layer stacks the line width will have to follow line routing rules, avoiding 90 degree corners and using the shortest distance to the PCB's coaxial antenna connector.
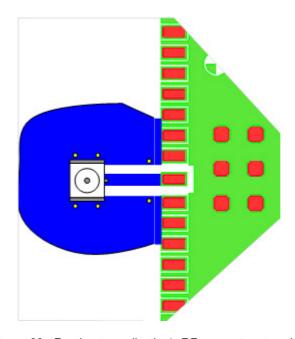
Figure 30: Routing to application's RF connector - top view
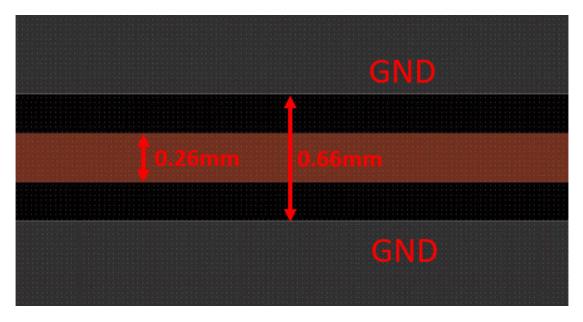
Figure 31: Routing detail

2.3   Sample Application

Figure 32 shows a typical example of how to integrate a ELS62 module with an application. Usage of the various host interfaces depends on the desired features of the application.

Because of the very low power consumption design, current flowing from any other source into the module circuit must be avoided, for example reverse current from high state external control lines. Therefore, the controlling application must be designed to prevent reverse current flow. Otherwise there is the risk of undefined states of the module during startup and shutdown or even of damaging the module.

Because of the high RF field density inside the module, it cannot be guaranteed that no self interference might occur, depending on frequency and the applications grounding concept. The potential interferers may be minimized by placing small capacitors (47pF) at suspected lines (e.g. RXD0, VDDLP, and ON).

While developing SMT applications it is strongly recommended to provide test points for certain signals, i.e., lines to and from the module - for debug and/or test purposes. The SMT application should allow for an easy access to these signals. For details on how to implement test points see [4].

The EMC measures are best practice recommendations. In fact, an adequate EMC strategy for an individual application is very much determined by the overall layout and, especially, the position of components.

Depending on the micro controller used by an external application ELS62's digital input and output lines may require level conversion. Section 2.3.1 shows a possible sample level conversion circuit.

Note: ELS62 is not intended for use with cables longer than 3m.

Disclaimer
No warranty, either stated or implied, is provided on the sample schematic diagram shown in Figure 32 and the information detailed in this section. As functionality and compliance with national regulations depend to a great amount on the used electronic components and the individual application layout manufacturers are required to ensure adequate design and operating safeguards for their products using ELS62 modules.
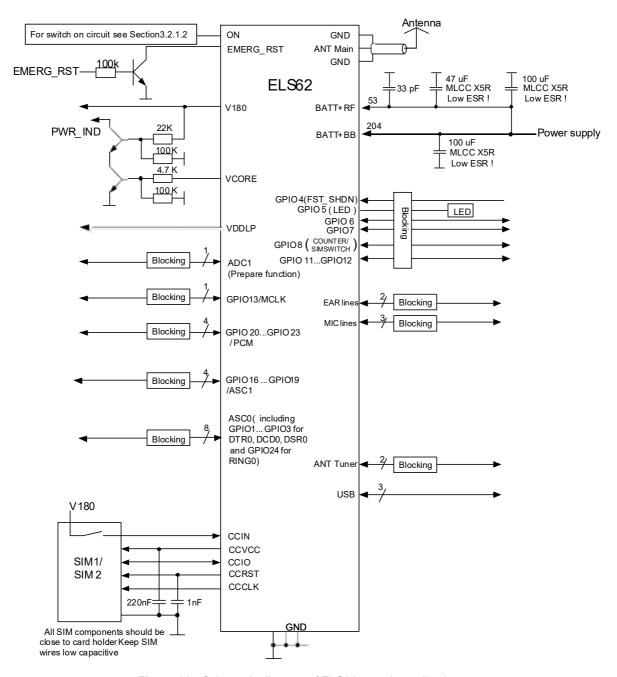
Figure 32: Schematic diagram of ELS62 sample application

2.3.1   Sample Level Conversion Circuit

Depending on the micro controller used by an external application ELS62's digital input and output lines (i.e., ASC0, ASC1 and GPIO lines) may require level conversion. The following Figure 33 shows a sample circuit with recommended level shifters for an external application's micro controller (with VLOGIC between 3.0V...3.6V). The level shifters can be used for digital input and output lines with V_{OH}max=1.85V or V_{IH}max =1.85V.
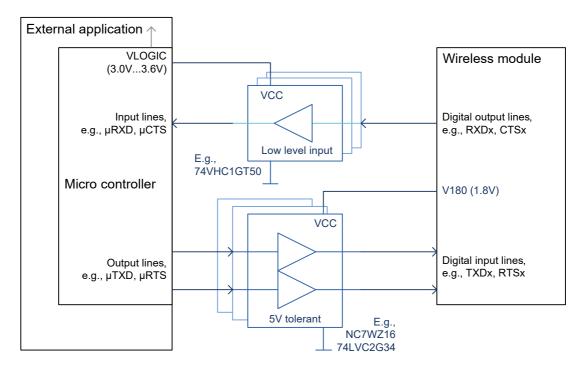
Figure 33: Sample level conversion circuit

3 Operating Characteristics

3.1 Operating Modes

The table below briefly summarizes the various operating modes referred to throughout the document.

Table 13: Overview of operating modes

Mode	Function	
Normal operation	GSM / GPRS/ LTE SLEEP	Power saving set automatically when no call is in progress and the USB connection is suspended by host or not present and no active communication via ASC0.
	GSM / GPRS/ LTE IDLE	Power saving disabled or an USB connection not suspended, but no call in progress.
	GSM TALK/ GSM DATA	Connection between two subscribers is in progress. Power consumption depends on the GSM network coverage and several connection settings (e.g. DTX off/on, FR/EFR/HR, hopping sequences and antenna connection). The following applies when power is to be measured in TALK_GSM mode: DTX off, FR and no frequency hopping.
	GPRS DATA	GPRS data transfer in progress. Power consumption depends on network settings (e.g. power control level), uplink / downlink data rates and GPRS configuration (e.g. used multislot settings).
	EGPRS DATA	EGPRS data transfer in progress. Power consumption depends on network settings (e.g. power control level), uplink / downlink data rates and EGPRS configuration (e.g. used multislot settings).
	LTE DATA	LTE data transfer in progress. Power consumption depends on network settings (e.g. TPC Pattern) and data transfer rate.
Power Down	Normal shutdown after sending the power down command. Only a voltage regulator is active for powering the RTC. Software is not active. Interfaces are not accessible. Operating voltage remains applied.	
Airplane mode	Airplane mode shuts down the radio part of the module, causes the module to log off from the network and disables all AT commands whose execution requires a radio connection. Airplane mode can be controlled by AT command (see [1]).	
Alarm mode	Restricted operation launched by RTC alert function when the module is in Power Down mode. In Alarm mode, the module remains deregistered from the network. Limited number of AT commands is accessible.	

3.2   Power Up/Power Down Scenarios

In general, be sure not to turn on ELS62 while it is beyond the safety limits of voltage and temperature stated in Section 2.1.2.1. ELS62 immediately switches off after having started and detected these inappropriate conditions. In extreme cases this can cause permanent damage to the module.

3.2.1   Turn on ELS62

ELS62 can be turned on as described in the following sections:
*   Connecting the operating voltage BATT+ (see Section 3.2.1.1).
*   Hardware driven switch on by ON line: Starts Normal mode (see Section 3.2.1.2).

After startup or restart, the module will send the URC ^SYSSTART that notifies the host application that the first AT command can be sent to the module (see also [1]).

3.2.1.1 Connecting ELS62 BATT+ Lines

Figure 34 shows sample external application circuits that allow to connect (and also to temporarily disconnect) the module's BATT+ lines from the external application's power supply.

Figure 34 illustrates the application of power employing an externally controlled microcontroller. The voltage supervisory circuit ensures that the power is disconnected and applied again depending on given thresholds.

The transistor T2 mentioned in Figure 34 should have an R_{DS_ON} value $\leq 50m\Omega$ in order to minimize voltage drops.

Such circuits could be useful to maximize power savings for battery driven applications or to completely switch off and restart the module after a firmware update.

After connecting the BATT+ lines the module can then be (re-)started as described in Section 3.2.1.2 and Section 3.2.2.
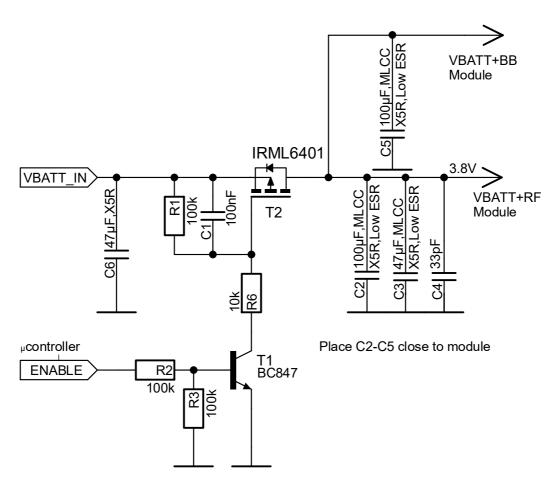
Figure 34: Sample circuit for applying power using an external µC

3.2.1.2 Switch on ELS62 Using ON Signal

After the operating voltage BATT+ is applied, ELS62 can be switched on by means of the ON signal.

The ON signal is an edge triggered signal and allows the input voltage level up to 5V. The module starts into normal mode on detecting the rising edge of the ON signal. The rising edge of ON signal must be applied at least 100 milliseconds later than BATT+. See Figure 36.

The following Figure 35 shows recommendations for possible switch-on circuits.
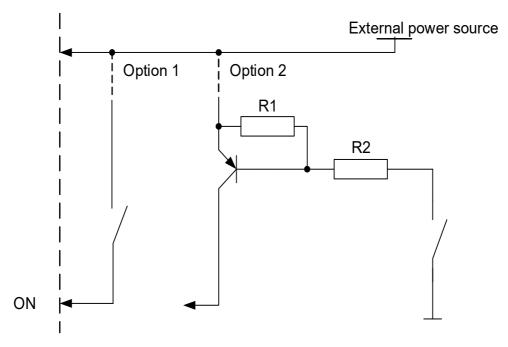
Figure 35: ON circuit options

The recommended external power source is 1.3~4.5V, with Option 2 the typical resistor values are: R1 = 150k and R2 = 3k. But the resistor values depend on the cur rent gain from the employed PNP resistor.

Please note that the ON signal is an edge triggered signal. This implies that a micro-second high pulse on the signal line suffices to almost immediately switch on the module, as shown in Figure 36. After module startup the ON signal should always be set to low to prevent possible back powering at this pad.[1]

---

1. Please take due discretion when designing the filtering circuit, especially ESD, which may cause unintended switch on.
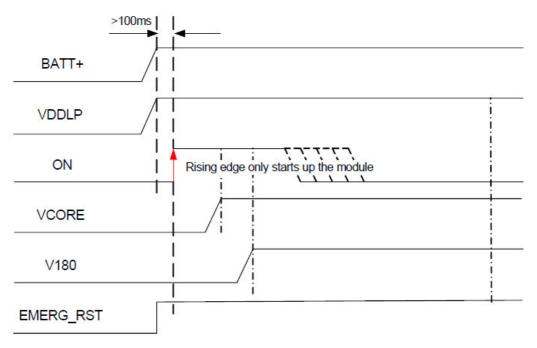
Figure 36: ON timing

3.2.1.3   Automatic Power On

In case an automatic power on function is required for an external module application, circuits such as shown in either Figure 37.
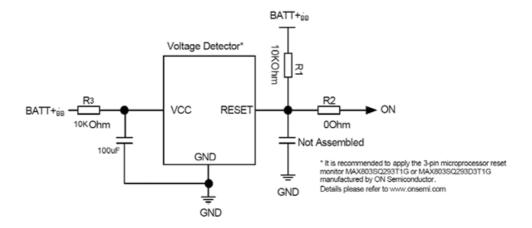
Figure 37: Automatic ON circuit

3.2.2   Restart ELS62

After startup ELS62 can be re-started as described in the following sections:
- Software controlled reset by AT+CFUN command: Starts Normal mode (see Section 3.2.2.1).
- Hardware controlled reset by EMERG_RST line: Starts Normal mode (see Section 3.2.2.2).

3.2.2.1   Restart ELS62 via AT+CFUN Command

To reset and restart the ELS62 module use the command AT+CFUN. See [1] for details.

3.2.2.2   Restart ELS62 Using EMERG_RST

The EMERG_RST signal is internally connected to the main module processor. A low level for more than 10ms sets the processor, and with it all the other signal pads to their respective reset state. If the EMERG_RST signal is pulled to GND, the module state remains unchanged and will not to startup. The reset state is described in Section 3.2.3 as well as in the figures showing the startup behavior of an interface.

After releasing the EMERG-RST line, i.e., with a change of the signal level from low to high, the module restarts. The other signals continue from their reset state as if the module was switched on by the ON signal.
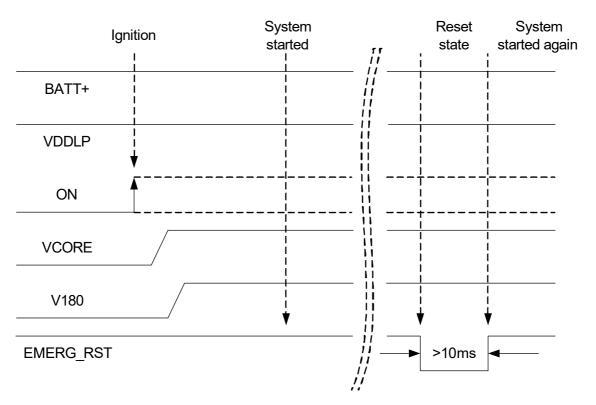
Figure 38: Emergency reset timing

It is recommended to control this EMERG_RST line with an open collector transistor or an open drain field-effect transistor.

Caution: Use the EMERG_RST line only when, due to serious problems, the software is not responding for more than 5 seconds. Pulling the EMERG_RST line causes the loss of all information stored in the volatile memory. Therefore, this procedure is intended only for use in case of emergency, e.g. if ELS62 does not respond, if reset or shutdown via AT command fails.

3.2.3 Signal States after Startup

Table 14 lists the states each interface signal passes through during reset phase and the first firmware initialization. For further firmware startup initializations the values may differ because of different GPIO line configurations.

The reset state is reached with the rising edge of the EMERG_RST signal - either after a normal module startup (see Section 3.2.1.2) or after a reset (see Section 3.2.2.2). After the reset state has been reached the firmware initialization state begins. The firmware initialization is completed as soon as the ASC0 interface lines CTS0, DSR0 and RING0 as well as the ASC1 interface line CTS1 have turned low (see Section 2.1.4 and Section 2.1.5). Now, the module is ready to receive and transmit data.

Table 14: Signal states

Signal name	Reset state	First start up configuration
CCIO	TBD	TBD
CCRST	TBD	TBD
CCCLK	TBD	TBD
CCIN	TBD	TBD
RXD0	TBD	TBD
TXD0	TBD	TBD
CTS0	TBD	TBD
RTS0	TBD	TBD
GPIO1	TBD	TBD
GPIO2	TBD	TBD
GPIO3	TBD	TBD
GPIO4	TBD	TBD
GPIO5	TBD	TBD
GPIO6	TBD	TBD
GPIO7	TBD	TBD
GPIO8	TBD	TBD
GPIO11-GPIO13	TBD	TBD
GPIO14-GPIO15	TBD	TBD
GPIO16-GPIO20	TBD	TBD
GPIO21	TBD	TBD
GPIO22	TBD	TBD
GPIO23	TBD	TBD
GPIO24	TBD	TBD

Note: The PD are On to always keep present even the GPIO is set to I (input).
Abbreviations used in above Table 14:

L = Low level	O = Output
H = High level	OD = Open Drain
T = Tristate	PD = Pull down
I = Input	PU = Pull up

3.2.4   Turn off ELS62

To switch the module off the following procedures may be used:
- *Software controlled shutdown procedure*: Software controlled by sending an AT command over the serial application interface. See Section 3.2.4.1.
- *Hardware controlled shutdown procedure*: Hardware controlled by setting the FST_SHDN line to low. See Section 2.1.11.4
- *Automatic shutdown (software controlled)*: See Section 3.2.5
  - Takes effect if ELS62 board temperature or voltage levels exceed a critical limit.

3.2.4.1   Switch off ELS62 Using AT Command

The best and safest approach to powering down ELS62 is to issue the appropriate AT command. This procedure lets ELS62 log off from the network and allows the software to enter into a secure state and safe data before disconnecting the power supply. The mode is referred to as Power Down mode. In this mode, only the RTC stays active. After sending the switch off command AT^SMSO, be sure not to enter any further AT commands until the module was restarted.

CAUTION: Be sure not to disconnect the operating voltage V_{BATT+} before V180 pad has gone low. Otherwise you run the risk of losing data, or in some rare cases even to render the module inoperable.

To monitor the V180 line, it is recommended to implement a power indication circuit as described in Section 2.1.11.2.

While ELS62 is in Power Down mode the application interface is switched off and must not be fed from any other voltage source. **Therefore, your application must be designed to avoid any current flow into any digital pads of the application interface.**
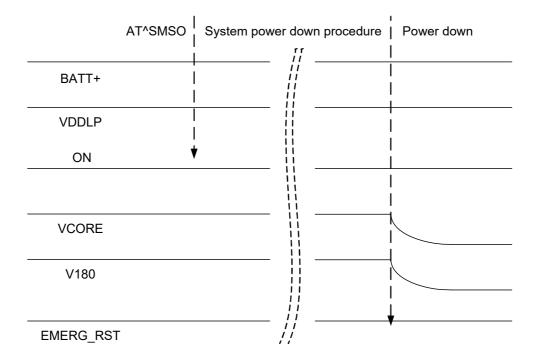
Figure 39: Switch off behavior

3.2.5　Automatic Shutdown

Automatic shutdown takes effect if the following event occurs:
- ELS62 board is exceeding the critical limits of overtemperature or undertemperature (see Section 3.2.5.1)
- Undervoltage or overvoltage is detected (see Section 3.2.5.2 and Section 3.2.5.3)

The automatic shutdown procedure is equivalent to the power-down initiated with an AT command, i.e. ELS62 logs off from the network and the software enters a secure state avoiding loss of data.

3.2.5.1　Thermal Shutdown

Each time the board temperature goes out of range (-20°C to +85°C) or back to normal, ELS62 instantly displays an alert (if enabled).
- URCs indicating the level "1" or "-1" allow the user to take appropriate precautions, such as protecting the module from exposure to extreme conditions. The presentation of the URCs depends on the settings selected with the AT^SCTM write command (for details see [1]): AT^SCTM=1: Presentation of URCs is always enabled.

  AT^SCTM=0 (default): Presentation of URCs is enabled during the 2 minute guard period after start-up of ELS62. After expiry of the 2 minute guard period, the presentation of URCs will be disabled, i.e. no URCs with alert levels "1" or "-1" will be generated.

- URCs indicating the level "2" or "-2" are instantly followed by an orderly shutdown. The presentation of these URCs is always enabled, i.e. they will be output even though the factory setting AT^SCTM=0 was never changed.

The maximum temperature ratings are stated in Section 3.5. Refer to Table 15 for the associated URCs.

Table 15: Temperature dependent behavior

Sending temperature alert (2min after ELS62 start-up, otherwise only if URC presentation enabled)	
^SCTM_B: 1	Board close to overtemperature limit.
^SCTM_B: -1	Board close to undertemperature limit.
^SCTM_B: 0	Board back to non-critical temperature range.
Automatic shutdown (URC appears no matter whether or not presentation was enabled)	
^SCTM_B: 2	Alert: Board equal or beyond overtemperature limit. ELS62 switches off.
^SCTM_B: -2	Alert: Board equal or below undertemperature limit. ELS62 switches off.

3.2.5.2　Undervoltage Shutdown

The undervoltage shutdown threshold is the specified minimum supply voltage V_{BATT+} given in Table 2. When the average supply voltage measured by ELS62 approaches the undervoltage shutdown threshold (i.e., 0.05V offset) the module will send the following URC:

　　^SBC: Undervoltage Warning

When the voltage drops to <3.2V, the undervoltage warning is sent only once - until the next time the module is close to the undervoltage shutdown threshold.

If the voltage continues to drop to ≤3.0V, the module will send the following URC:
    ^SBC: Undervoltage Shutdown

This alert is sent only once before the module shuts down cleanly without sending any further messages.

This type of URC does not need to be activated by the user. It will be output automatically when fault conditions occur.

Note: For battery powered applications it is strongly recommended to implement a BATT+ connecting circuit as described in Section 3.2.1.1 in order to not only be able save power, but also to restart the module after an undervoltage shutdown where the battery is deeply discharged. Also note that the undervoltage threshold is calculated for max. 200mV voltage drops during transmit burst. Power supply sources for external applications should be designed to tolerate 200mV voltage drops without crossing the lower limit of 3.0V. For external applications operating at the limit of the allowed tolerance the default undervoltage threshold may be adapted by subtracting an offset. For details see [1]: AT^SCFG= "MEShutdown/sVsup/threshold".

If the module will be supplied by <2.9V the module will have a under voltage lock out which results in an ungraceful shutdown. This is not recommended! Thales recommend the customer shall implement fast shutdown.

3.2.5.3 Overvoltage Shutdown

The overvoltage shutdown threshold is the specified maximum supply voltage V_{BATT+} given in Table 2. When the average supply voltage measured by ELS62 approaches the overvoltage shutdown threshold (i.e., 0.05V offset) the module will send the following URC:

    ^SBC: Overvoltage Warning

When the voltage rises to >4.5V, the overvoltage warning is sent only once - until the next time the module is close to the overvoltage shutdown threshold.

If the voltage continues to rise to ≥4.7V, the module will send the following URC:

    ^SBC: Overvoltage Shutdown

This alert is sent only once before the module shuts down cleanly without sending any further messages.

This type of URC does not need to be activated by the user. It will be output automatically when fault conditions occur.

Keep in mind that several ELS62 components are directly linked to BATT+ and, therefore, the supply voltage remains applied at major parts of ELS62. Especially the power amplifier linked to $BATT+_{RF}$ is very sensitive to high voltage and might even be destroyed.

3.3 Power Saving

ELS62 can be configured in two ways to control power consumption:

- Using the AT command AT^SPOW it is possible to specify a so-called power saving mode for the module (<mode> = 2; for details on the command see [1]). The module's UART interfaces (ASC0 and ASC1) are then deactivated and will only periodically be activated to be able to listen to network paging messages as described in Section 3.3.1, Section and Section 3.3.2. See Section 3.3.3 for a description on how to immediately wake up ELS62 again using RTS0.

  Please note that the AT^SPOW setting has no effect on the USB interface. As long as the USB connection is active, the module will not change into its SLEEP state to reduce its functionality to a minimum and thus minimizing its current consumption. To enable switching into SLEEP mode, the USB connection must therefore either not be present at all or the USB host must bring its USB interface into Suspend state. Also, VUSB_IN should always be kept enabled for this functionality. See "Universal Serial Bus Specification Revision 2.0"[1] for a description of the Suspend state.

- Using the AT command AT^SCFG="Radio/OutputPowerReduction" it is possible for the module in GPRS and EGPRS multislot scenarios to reduce its output power according to 3GPP 45.005 section. By default a maximum power reduction is enabled. For details on the command see [1].

3.3.1 Power Saving while Attached to GSM Networks

The power saving possibilities while attached to a GSM network depend on the paging timing cycle of the base station. The duration of a power saving interval can be calculated using the following formula:

t = 4.615 ms (TDMA frame duration) * 51 (number of frames) * DRX value.

DRX (Discontinuous Reception) is a value from 2 to 9, resulting in paging intervals between 0.47 and 2.12 seconds. The DRX value of the base station is assigned by the GSM network operator.

In the pauses between listening to paging messages, the module resumes power saving, as shown in Figure 40.
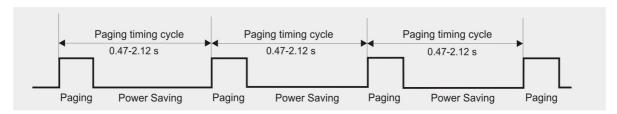
Figure 40: Power saving and paging in GSM networks

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1. The specification is ready for download on http://www.usb.org/developers/docs/

The varying pauses explain the different potential for power saving. The longer the pause the less power is consumed.

Generally, power saving depends on the module's application scenario and may differ from the above mentioned normal operation. The power saving interval may be shorter than 0.47 seconds or longer than 2.12 seconds.

3.3.2 Power Saving while Attached to LTE Networks

The power saving possibilities while attached to an LTE network depend on the paging timing cycle of the base station.

During normal LTE operation, i.e., the module is connected to an LTE network, the duration of a power saving period varies. It may be calculated using the following formula:

t = DRX Cycle Value * 10 ms

DRX cycle value in LTE networks is any of the four values: 32, 64, 128 and 256, thus resulting in power saving intervals between 0.32 and 2.56 seconds. The DRX cycle value of the base station is assigned by the LTE network operator.

In the pauses between listening to paging messages, the module resumes power saving, as shown in Figure 41.
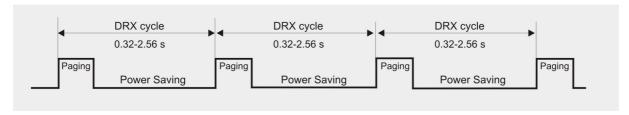
Figure 41: Power saving and paging in LTE networks

The varying pauses explain the different potential for power saving. The longer the pause the less power is consumed.

Generally, power saving depends on the module's application scenario and may differ from the above mentioned normal operation. The power saving interval may be shorter than 0.32 seconds or longer than 2.56 seconds.

3.3.3   Wake-up via RTS0

RTS0 can be used to wake up ELS62 from SLEEP mode configured with AT^SPOW. Assertion of RTS0 (i.e., toggle from inactive high to active low) serves as wake up event, thus allowing an external application to almost immediately terminate power saving. After RTS0 assertion, the CTS0 line signals module wake up, i.e., readiness of the AT command interface. It is therefore recommended to enable RTS/CTS flow control (default setting).

Figure 42 shows the described RTS0 wake up mechanism.
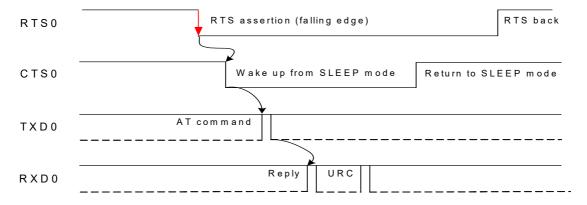
Figure 42: Wake-up via RTS0

3.4 Power Supply

ELS62 needs to be connected to a power supply at the SMT application interface - 2 lines BATT+, and GND. There are two separate voltage domains for BATT+:

- BATT+$_{BB}$ with a line mainly for the baseband power supply.
- BATT+$_{RF}$ with a line for the GSM/LTE power amplifier supply.

Please note that throughout the document BATT+ refers to both voltage domains and power supply lines - BATT+$_{BB}$ and BATT+$_{RF}$.

The power supply of ELS62 has to be a single voltage source at BATT+$_{BB}$ and BATT+$_{RF}$. It must be able to provide the peak current during the uplink transmission.

All the key functions for supplying power to the device are handled by the power management section of the analog controller. This IC provides the following features:

- Stabilizes the supply voltages for the baseband using low drop linear voltage regulators and a DC-DC step down switching regulator.
- Switches the module's power voltages for the power-up and -down procedures.
- SIM switch to provide SIM power supply.

3.4.1 Power Supply Ratings

Table 16 and Table 17 assemble various voltage supply and current consumption ratings of the module.

Table 16: Voltage supply ratings

	Description	Conditions	Min	Typ	Max	Unit
BATT+	Supply voltage	Directly measured at Module. Voltage must stay within the min/max values, including voltage drop, ripple, spikes.	3.0	3.8	4.5	V
	Maximum allowed voltage drop during transmit burst	Normal condition, power control level for Pout max			400	mV
	Voltage ripple	Normal condition, power control level for Pout max @ f <= 250 kHz @ f > 250 kHz				mV$_{pp}$ mV$_{pp}$

Table 17: Current consumption ratings[1]

	Description	Conditions		Typical rating	Unit
I_{BATT+}[2] (i.e., sum of $BATT+_{BB}$ and $BATT+_{RF}$)	OFF State supply current	Power Down		TBD	μA
	GSM SLEEP State supply current	SLEEP[3] @ DRX=9 (UART deactivated)	USB disconnected	TBD	mA
			USB suspended	TBD	mA
		SLEEP[3] @ DRX=5 (UART deactivated)	USB disconnected	TBD	mA
			USB suspended	TBD	mA
		SLEEP[3] @ DRX=2 (UART deactivated)	USB disconnected	TBD	mA
			USB suspended	TBD	mA
	GSM IDLE State supply current	IDLE[4] @ DRX=2 (UART activated, but no communication)	USB disconnected	TBD	mA
			USB suspended	TBD	mA
	Average GSM850 supply current[5]	GPRS Data transfer GSM850; PCL=5; 1Tx/4Rx	ROPR=4 (max. reduction)	TBD	mA
			ROPR=0 (no reduction)	TBD	mA
		GPRS Data transfer GSM850; PCL=5; 2Tx/3Rx	ROPR=4 (max. reduction)	TBD	mA
			ROPR=0 (no reduction)	TBD	mA
		GPRS Data transfer GSM850; PCL=5; 4Tx/1Rx	ROPR=4 (max. reduction)	TBD	mA
			ROPR=0 (no reduction)	TBD	mA
		EDGE Data transfer GSM850; PCL=5; 1Tx/4Rx	ROPR=4 (max. reduction)	TBD	mA
			ROPR=0 (no reduction)	TBD	mA
		EDGE Data transfer GSM850; PCL=5; 2Tx/3Rx	ROPR=4 (max. reduction)	TBD	mA
			ROPR=0 (no reduction)	TBD	mA
		EDGE Data transfer GSM850; PCL=5; 4Tx/1Rx	ROPR=4 (max. reduction)	TBD	mA
			ROPR=0 (no reduction)	TBD	mA

Table 17: Current consumption ratings[1]

	Description	Conditions		Typical rating	Unit
I_{BATT+}[2] (i.e., sum of $BATT+_{BB}$ and $BATT+_{RF}$)	Average GSM900 supply current[5]	GPRS Data transfer GSM900; PCL=0; 1Tx/4Rx	ROPR=4 (max. reduction)	TBD	mA
			ROPR=0 (no reduction)	TBD	mA
		GPRS Data transfer GSM900; PCL=0; 2Tx/3Rx	ROPR=4 (max. reduction)	TBD	mA
			ROPR=0 (no reduction)	TBD	mA
		GPRS Data transfer GSM900; PCL=0; 4Tx/1Rx	ROPR=4 (max. reduction)	TBD	mA
			ROPR=0 (no reduction)	TBD	mA
		EDGE Data transfer GSM900 PCL=0; 1Tx/4Rx	ROPR=4 (max. reduction)	TBD	mA
			ROPR=0 (no reduction)	TBD	mA
		EDGE Data transfer GSM900; PCL=0; 2Tx/3Rx	ROPR=4 (max. reduction)	TBD	mA
			ROPR=0 (no reduction)	TBD	mA
		EDGE Data transfer GSM900; PCL=0; 4Tx/1Rx	ROPR=4 (max. reduction)	TBD	mA
			ROPR=0 (no reduction)	TBD	mA
	Average GSM1800 supply current[5]	GPRS Data transfer GSM1800; PCL=0; 1Tx/4Rx	ROPR=4 (max. reduction)	TBD	mA
			ROPR=0 (no reduction)	TBD	mA
		GPRS Data transfer GSM1800; PCL=0; 2Tx/3Rx	ROPR=4 (max. reduction)	TBD	mA
			ROPR=0 (no reduction)	TBD	mA
		GPRS Data transfer GSM1800; PCL=0; 4Tx/1Rx	ROPR=4 (max. reduction)	TBD	mA
			ROPR=0 (no reduction)	TBD	mA
		EDGE Data transfer GSM1800 PCL=0; 1Tx/4Rx	ROPR=4 (max. reduction)	TBD	mA
			ROPR=0 (no reduction)	TBD	mA
		EDGE Data transfer GSM1800; PCL=0; 2Tx/3Rx	ROPR=4 (max. reduction)	TBD	mA
			ROPR=0 (no reduction)	TBD	mA
		EDGE Data transfer GSM1800; PCL=0; 4Tx/1Rx	ROPR=4 (max. reduction)	TBD	mA
			ROPR=0 (no reduction)	TBD	mA

Table 17: Current consumption ratings[1]

	Description	Conditions		Typical rating	Unit
	Average GSM1900 supply current[5]	GPRS Data transfer GSM1900; PCL=0; 1Tx/4Rx	ROPR=4 (max. reduction)	TBD	mA
			ROPR=0 (no reduction)	TBD	mA
		GPRS Data transfer GSM1900; PCL=0; 2Tx/3Rx	ROPR=4 (max. reduction)	TBD	mA
			ROPR=0 (no reduction)	TBD	mA
		GPRS Data transfer GSM1900; PCL=0; 4Tx/1Rx	ROPR=4 (max. reduction)	TBD	mA
			ROPR=0 (no reduction)	TBD	mA
		EDGE Data transfer GSM1900 PCL=0; 1Tx/4Rx	ROPR=4 (max. reduction)	TBD	mA
			ROPR=0 (no reduction)	TBD	mA
		EDGE Data transfer GSM1900; PCL=0; 2Tx/3Rx	ROPR=4 (max. reduction)	TBD	mA
			ROPR=0 (no reduction)	TBD	mA
		EDGE Data transfer GSM1900; PCL=0; 4Tx/1Rx	ROPR=4 (max. reduction)	TBD	mA
			ROPR=0 (no reduction)	TBD	mA
	Peak current Data transfer during GSM transmit burst[5]	GPRS Data transfer GSM850; PCL=5; 1Tx/1Rx @ 50Ω		TBD	A
		GPRS Data transfer GSM900; PCL=5; 1Tx/1Rx @ 50Ω		TBD	A
		GPRS Data transfer GSM1800; PCL=0; 1Tx/1Rx @ 50Ω		TBD	A
		GPRS Data transfer GSM1900; PCL=0; 1Tx/1Rx @ 50Ω		TBD	A
		GPRS Data transfer GSM850; PCL=5; 1Tx/1Rx @total mismatch		TBD	A
		GPRS Data transfer GSM900; PCL=5; 1Tx/1Rx @total mismatch		TBD	A
		GPRS Data transfer GSM1800; PCL=0; 1Tx/1Rx @total mismatch		TBD	A
		GPRS Data transfer GSM1900; PCL=0; 1Tx/1Rx @total mismatch		TBD	A

Table 17: Current consumption ratings[1]

	Description	Conditions		Typical rating	Unit
I_{BATT+}[2] (i.e., sum of $BATT+_{BB}$ and $BATT+_{RF}$)	Average LTE supply current Data transfer @ maximum Pout	SLEEP[3] @ "Paging Occasions" = 256 (UART deactivated)	USB disconnected	TBD	mA
			USB suspended	TBD	mA
		SLEEP[3] @ "Paging Occasions" = 128 (UART deactivated)	USB disconnected	TBD	mA
			USB suspended	TBD	mA
		SLEEP[3] @ "Paging Occasions" = 64 (UART deactivated)	USB disconnected	TBD	mA
			USB suspended	TBD	mA
		SLEEP[3] @ "Paging Occasions" = 32 (UART deactivated)	USB disconnected	TBD	mA
			USB suspended	TBD	mA
		IDLE[4]	USB disconnected	TBD	mA
		IDLE[4]	USB active	TBD	mA
		LTE[6] Data transfer Band 1 @max power[6]		TBD	mA
		LTE[4] Data transfer Band 2 @max power[6]		TBD	mA
		LTE[4] Data transfer Band 3 @max power[6]		TBD	mA
		LTE[4] Data transfer Band 4 @max power[6]		TBD	mA
		LTE[4] Data transfer Band 5 @max power[6]		TBD	mA
		LTE[4] Data transfer Band 7 @max power[6]		TBD	mA
		LTE[6] Data transfer Band 8 @max power[6]		TBD	mA
		LTE[6] Data transfer Band 20 @max power[6]		TBD	mA
		LTE[6] Data transfer Band 28 @max power[6]		TBD	mA
		LTE[4] Data transfer Band 34 @max power[6]		TBD	mA
		LTE[4] Data transfer Band 38 @max power[6]		TBD	mA
		LTE[4] Data transfer Band 39 @max power[6]		TBD	mA
		LTE[4] Data transfer Band 40 @max power[6]		TBD	mA
		LTE[4] Data transfer Band 41 @max power[6]		TBD	mA
		LTE[4] Data transfer Band 66 @max power[6]		TBD	mA

1. Note: Current consumption ratings are based on measurements done in a laboratory test environment and deviations may occur from the given typical rating. Under real life conditions however, with e.g., varying network quality, location changes, or changing supply currents, the deviation from these typical ratings may be even bigger, and will have to be taken into account for actual power supply solutions. For more details on power supply design see [4].

2. With an impedance of $Z_{LOAD}=50\Omega$ at the antenna pad.Measured at 25°C and 3.8V.

3. Measurements start 6 minutes after switching ON the module;

Averaging times: SLEEP mode - 3 minutes, transfer modes - 1.5 minutes

Communication tester settings: No neighbor cells, no cell re-selection etc., RMC (reference measurement channel). Note that SLEEP mode is enabled via AT Command AT^SPOW=2,1000,3

4. The power save mode is disabled via AT command AT^SPOW=1,0,0

5. Communication tester setting: Channel: Middle Channel

6. Communication tester settings:

Channel Bandwidth: 5MHz

Channel: Middle Channel

Number of Resource Blocks: 25 (DL), 1 (UL) , RB position: Low

Modulation: QPSK

3.4.2 Minimizing Power Losses

When designing the power supply for your application please pay specific attention to power losses. Ensure that the input voltage V_{BATT+} never drops below 3.0V on the ELS62 board, not even in a GSM transmit burst where current consumption can rise (for peak values see the power supply ratings listed in).
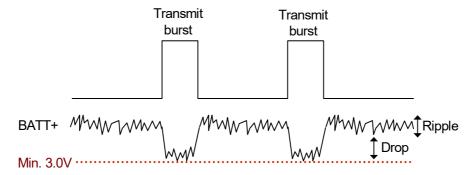
Figure 43: Power supply limits during transmit burst

3.4.3 Measuring the Supply Voltage (V_{BATT+})

To measure the supply voltage V_{BATT+} it is possible to define two reference points GND and BATT+. GND should be the module's shielding, while BATT+ should be a test pad on the external application the module is mounted on. The external BATT+ reference point has to be connected to and positioned close to the SMT application interface's BATT+ pads 53 (BATT+$_{RF}$) or 204 (BATT+$_{BB}$) as shown in Figure 44.

Reference point BATT+:
External test pad connected to and positioned closely to BATT+ pad 53 or 204.

Reference point GND:
Module shielding

External application
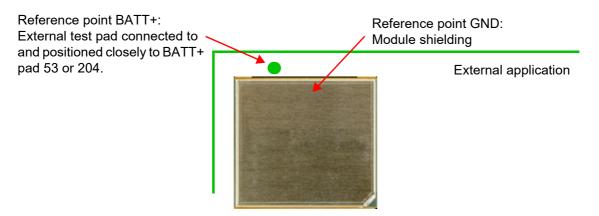
Figure 44: Position of reference points BATT+ and GND

3.4.4 Monitoring Power Supply by AT Command

To monitor the supply voltage you can also use the AT^SBV command which returns the value related to the reference points BATT+ and GND.

The module continuously measures the voltage at intervals depending on the operating mode of the RF interface. The duration of measuring ranges from 0.5 seconds in TALK/DATA mode to 50 seconds when ELS62 is in IDLE mode or Limited Service (deregistered). The displayed voltage (in mV) is averaged over the last measuring period before the AT^SBV command was executed.

If the measured voltage drops below or rises above the voltage shutdown thresholds, the module will send an "^SBC" URC and shut down (for details see Section 3.2.5).

3.5   Operating Temperatures

Please note that the module's lifetime, i.e., the MTTF (mean time to failure) may be reduced, if operated outside the extended temperature range.

Table 18: Board temperature

Parameter	Min	Typ	Max	Unit
Normal operation	-20	+25	+85	°C
Extended operation[1]	-30		+90	°C

Automatic shutdown[2]
    Temperature measured on ELS62
    board
	<-30	---	>+90	°C

1. Extended operation allows normal mode speech calls or data transmission for limited time until automatic thermal shutdown takes effect. Within the extended temperature range (outside the normal operating temperature range) the specified electrical characteristics may be in- or decreased.
2. The board temperature is corresponding to the measured chipset temperature.

See also Section 3.2.5 for information about the board temperature measurement, automatic thermal shutdown and alert messages.

Note: Within the specified operating temperature ranges the board temperature may vary to a great extent depending on operating mode, used frequency band, radio output power and current supply voltage.

For more information regarding the module's thermal behavior please refer to [5].

3.6 Electrostatic Discharge

The module is not protected against Electrostatic Discharge (ESD) in general. Consequently, it is subject to ESD handling precautions that typically apply to ESD sensitive components. Proper ESD handling and packaging procedures must be applied throughout the processing, handling and operation of any application that incorporates a ELS62 module.

An example for an enhanced ESD protection for the SIM interface is given in Section 2.1.6.1.

ELS62 has been tested according to group standard ETSI EN 301 489-1 (see Table 26) and test standard EN 61000-4-2. Electrostatic values can be gathered from the following table.

Table 19: Electrostatic values

Specification/Requirements	Contact discharge	Air discharge
EN 61000-4-2		
Antenna interfaces	TBD	TBD
Antenna interfaces with ESD protection (see Section 3.6.1)	TBD	TBD
BATT+	TBD	TBD
JEDEC JESD22-A114D (Human Body Model, Test conditions: 1.5 kΩ, 100 pF)		
All other interfaces	TBD	TBD.

Note: The values may vary with the individual application design. For example, it matters whether or not the application platform is grounded over external devices like a computer or other equipment, such as the Thales reference application described in Chapter 5.

3.7 Blocking against RF on Interface Lines

There are no general blocking measures at LGA pads on ELS62-W to the external application. In the EMERG_RST, and SIM interface lines are serial resistors, or capacitors to GND, implemented to reduce the EMI and ESD problems. All other signal lines have no EMI measures on the Module.

Exceptions:Supply voltages BATT+BB, BATT+RF, V180, VDDLP, CCVCC1 and CCVCC2 are decoupled with capacitors to GND.
The analogue audio lines are blocked with capacitors against EMI.

The main power supply from an external application has to be a single voltage source and has to be expanded to two sub paths (star structure). Each voltage domain must be decoupled by application with low ESR capacitors (>100µF MLCC X5R@ BATT+BB; >(100+47)µF MLCC X5R@ BATT+RF) as close as possible to LGA pads.
It could be possible to use EMI measures in the application with the module on some signal lines. The EMI measures are described in the following.
There are five combinations with electronic devices between module and application.
The maximum value of the serial resistor should be lower than 1k ohm in the signal line. The maximum value of the capacitor should be lower than 50pF at the signal line. Please observe the electrical specification of the module interface and the application interface. Pay attention not to exceed the maximum input voltages and prevent voltage overshoot's, which might occur if using inductive EMC measures.
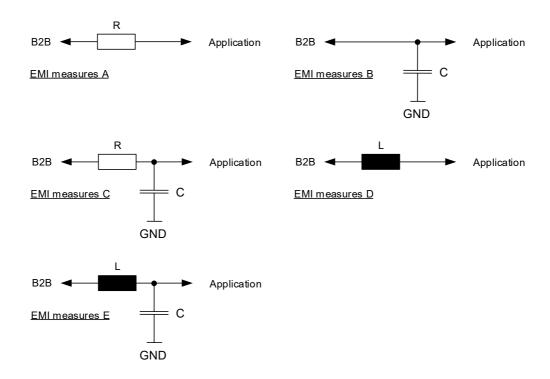
Figure 45: EMI circuits

The following table lists for each signal line at the module's SMT application interface the EMI measures that may be implemented.

Table 20: EMI measures on the application interface

Signal name	EMI measures					Remark
	A	B	C	D	E	
CCINx	x			x		
CCRSTx		x				The external capacitor should be not higher than 30pF. The value of the capacitor depends on the external application.
CCIOx		x				
CCCLKx		x				
USB_DP						It is not allowed to use any external ESD or EMI components at this interface signal lines.
USB_DN						
RXD0	x	x	x	x	x	
TXD0	x	x	x	x	x	
CTS0	x	x	x	x	x	
RTS0	x	x	x	x	x	
GPIO1/DTR0	x	x	x	x	x	
GPIO2/DCD0	x	x	x	x	x	
GPIO3/DSR0	x	x	x	x	x	
GPIO4/FST_SHDN	x	x	x	x	x	
GPIO5/LED	x	x	x	x	x	
GPIO6/PWM2	x	x	x	x	x	
GPIO7/PWM1	x	x	x	x	x	
GPIO8/COUNTER	x	x	x	x	x	
GPIO11-GPIO15	x	x	x	x	x	
GPIO16/RXD1/MOSI	x	x	x	x	x	
GPIO17/TXD1/MISO	x	x	x	x	x	
GPIO18/RTS1	x	x	x	x	x	
GPIO19/CTS1/SPI_CS	x	x	x	x	x	
GPIO20	x	x	x	x	x	
GPIO21/	x	x	x	x	x	
GPIO22	x	x	x	x	x	
GPIO23	x	x	x	x	x	
GPIO24/RING0	x	x	x	x	x	
GPIO25	x	x	x	x	x	
GPIO26/SIM_SWITCH	x	x	x	x	x	
V180		x		x	x	
VDDLP		x		x	x	
BATT+$_{RF}$		x	x			Measures required if BATT+$_{RF}$ is close to internal RF antenna - e.g., 39pF blocking capacitor to ground
BATT+$_{BB}$ (pad 204)		x	x			

3.8 Reliability Characteristics

The test conditions stated below are an extract of the complete test specifications.
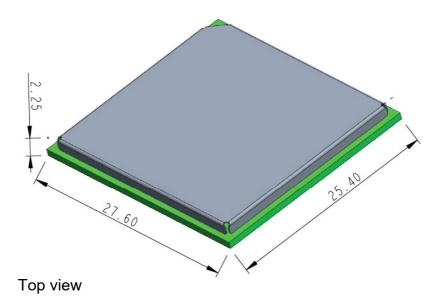
Table 21: Summary of reliability test conditions

Type of test	Conditions	Standard
Vibration	Frequency range: 10-20Hz; acceleration: 5g Frequency range: 20-500Hz; acceleration: 15g Duration: 2h per axis; 3 axes	DIN IEC 60068-2-6[1]
Shock half-sinus	Acceleration: 500g Shock duration: 1ms 1 shock per axis 6 positions (± x, y and z)	DIN IEC 60068-2-27
Dry heat	Temperature: +70 ±2°C Test duration: 16h Humidity in the test chamber: < 50%	EN 60068-2-2 Bb ETS 300 019-2-7
Temperature change (shock)	Low temperature: -40°C ±2°C High temperature: +85°C ±2°C Changeover time: < 30s (dual chamber system) Test duration: 1h Number of repetitions: 100	DIN IEC 60068-2-14 Na ETS 300 019-2-7
Damp heat cyclic	High temperature: +55°C ±2°C Low temperature: +25°C ±2°C Humidity: 93% ±3% Number of repetitions: 6 Test duration: 12h + 12h	DIN IEC 60068-2-30 Db ETS 300 019-2-5
Cold (constant exposure)	Temperature: -40 ±2°C Test duration: 16h	DIN IEC 60068-2-1
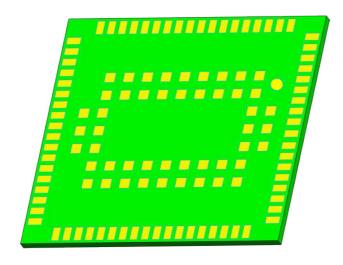
1. For reliability tests in the frequency range 20-500Hz the Standard's acceleration reference value was increased to 15g.

4 Mechanical Dimensions, Mounting and Packaging

4.1 Mechanical Dimensions of ELS62
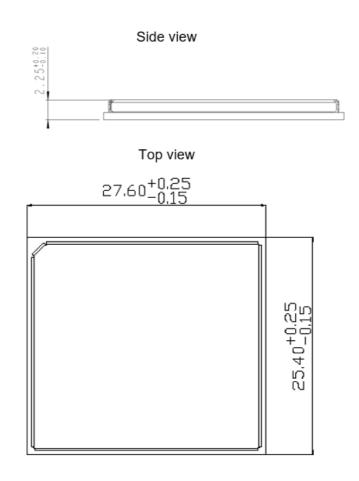
Figure 46 shows the top and bottom view of ELS62 and provides an overview of the board's mechanical dimensions. For further details see Figure 47.

Top view

Bottom view

Figure 46: ELS62– top and bottom view

4.1 Mechanical Dimensions of ELS62
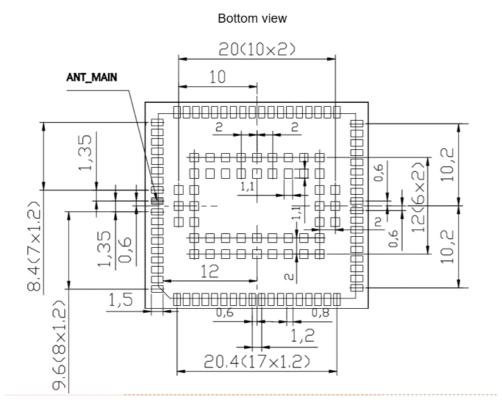
Figure 47: Dimensions of ELS62 (all dimensions in mm)

4.2 Mounting ELS62 onto the Application Platform

This section describes how to mount ELS62 onto the PCBs, including land pattern and stencil design, board-level characterization, soldering conditions, durability and mechanical handling. For more information on issues related to SMT module integration see also [4].

Note: To avoid short circuits between signal tracks on an external application's PCB and various markings at the bottom side of the module, it is recommended not to route the signal tracks on the top layer of an external PCB directly under the module, or at least to ensure that signal track routes are sufficiently covered with solder resist.

4.2.1 SMT PCB Assembly

4.2.1.1 Land Pattern and Stencil

The land pattern and stencil design as shown below is based on Thales characterizations for lead-free solder paste on a four-layer test PCB and a respectively 110 µm and 150 µm thick stencil.

The land pattern given in Figure 48 reflects the module's pad layout, including signal pads and ground pads (for pad assignment see Section 2.1.1).
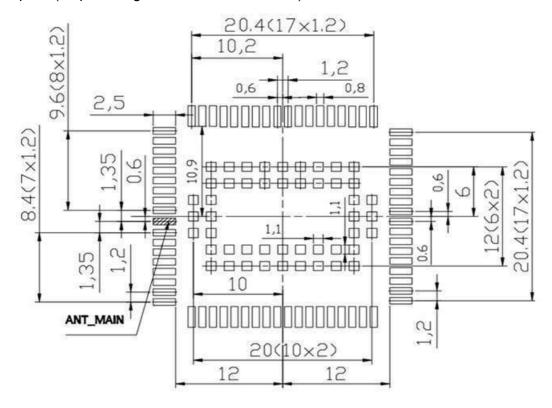
Figure 48: Land pattern (top view)

The stencil design illustrated in Figure 49 and Figure 50 is recommended by Thales as a result of extensive tests with Thales Daisy Chain modules.

The central ground pads are primarily intended for stabilizing purposes, and may show some more voids than the application interface pads at the module's rim. This is acceptable, since they are electrically irrelevant.
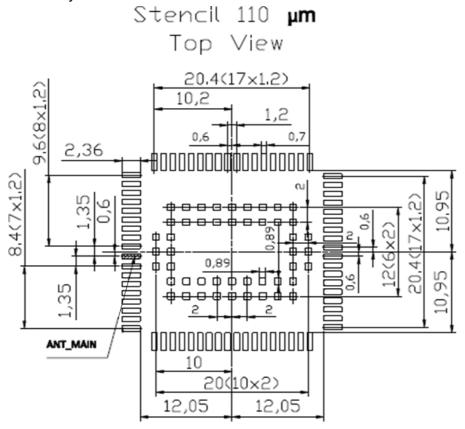
Figure 49: Recommended design for 110µm thick stencil (top view)
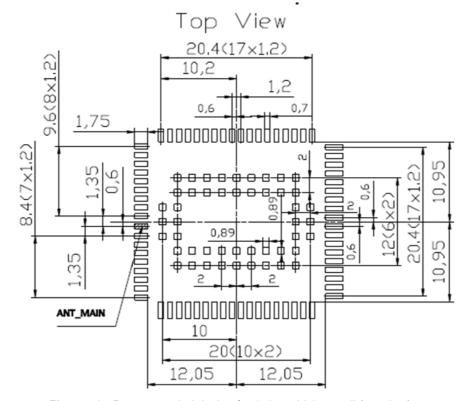
Figure 50: Recommended design for 150µm thick stencil (top view)

4.2.1.2 Board Level Characterization

Board level characterization issues should also be taken into account if devising an SMT process.

Characterization tests should attempt to optimize the SMT process with regard to board level reliability. This can be done by performing the following physical tests on sample boards: Peel test, bend test, tensile pull test, drop shock test and temperature cycling. Sample surface mount checks are described in [4].

It is recommended to characterize land patterns before an actual PCB production, taking individual processes, materials, equipment, stencil design, and reflow profile into account. For land and stencil pattern design recommendations see also Section 4.2.1.1. Optimizing the solder stencil pattern design and print process is necessary to ensure print uniformity, to decrease solder voids, and to increase board level reliability.

Daisy chain modules for SMT characterization are available on request. For details refer to [4].

Generally, solder paste manufacturer recommendations for screen printing process parameters and reflow profile conditions should be followed. Maximum ratings are described in Section 4.2.3.

4.2.2 Moisture Sensitivity Level

ELS62 comprises components that are susceptible to damage induced by absorbed moisture.

Thales' ELS62 module complies with the latest revision of the IPC/JEDEC J-STD-020 Standard for moisture sensitive surface mount devices and is classified as MSL 4.

For additional moisture sensitivity level (MSL) related information see Section 4.2.4 and Section 4.3.2.

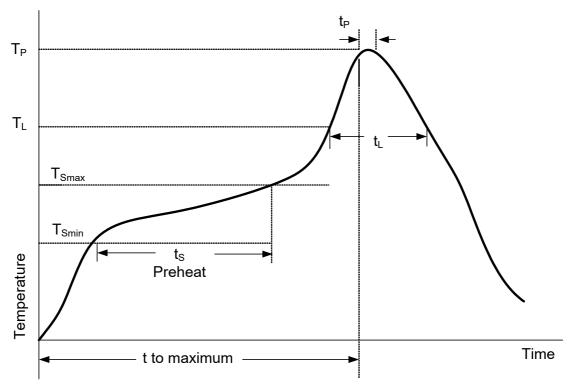## 4.2.3 Soldering Conditions and Temperature

4.2.3.1 Reflow Profile
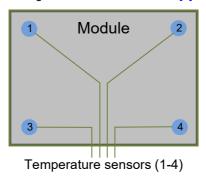
Figure 51: Reflow Profile

Table 22: Reflow temperature ratings[1]

Profile Feature	Pb-Free Assembly
Preheat & Soak Temperature Minimum (T_{Smin}) Temperature Maximum (T_{Smax}) Time (t_{Smin} to t_{Smax}) (t_S)	150°C 200°C 60-120 seconds
Average ramp-up rate (T_L to T_P)	3K/second max. [2]
Liquidous temperature (T_L) Time at liquidous (t_L)	217°C 50-90 seconds
Peak package body temperature (T_P)	245°C +0/-5°C
Time (t_P) within 5 °C of the peak package body temperature (T_P)	30 seconds max.
Limited ramp-down rate (Tp - 200°C) Average ramp-down rate from 200°C	1K/second max. [2] 3K-6K/second max. [2]
Time 25°C to maximum temperature	8 minutes max.

1. Please note that the reflow profile features and ratings listed above are based on the joint industry standard IPC/JEDEC J-STD-020D.1, and are as such meant as a general guideline. For more information on reflow profiles and their optimization please refer to [4].
2. Temperatures measured on shielding at each corner. See also [4].

Temperature sensors (1-4)

4.2.3.2   Maximum Temperature and Duration

The following limits are recommended for the SMT board-level soldering process to attach the module:
- A maximum module temperature of 245°C. This specifies the temperature as measured at the module's top side.
- A maximum duration of 30 seconds at this temperature.

Please note that while the solder paste manufacturers' recommendations for best temperature and duration for solder reflow should generally be followed, the limits listed above must not be exceeded.

ELS62 is specified for one soldering cycle only. Once ELS62 is removed from the application, the module will very likely be destroyed and cannot be soldered onto another application.

4.2.4 Durability and Mechanical Handling

4.2.4.1 Storage Conditions

ELS62 modules, as delivered in tape and reel carriers, must be stored in sealed, moisture barrier anti-static bags. The conditions stated below are only valid for modules in their original packed state in weather protected, non-temperature-controlled storage locations. Normal storage time under these conditions is 12 months maximum.

Table 23: Storage conditions

Type	Condition	Unit	Reference
Air temperature: Low High	-25 +40	°C	IPC/JEDEC J-STD-033D
Humidity relative: Low High	10 90 at 40°C	%	IPC/JEDEC J-STD-033D
Air pressure: Low High	70 106	kPa	IEC TR 60271-3-1: 1K4 IEC TR 60271-3-1: 1K4
Movement of surrounding air	1.0	m/s	IEC TR 60271-3-1: 1K4
Water: rain, dripping, icing and frosting	Not allowed	---	---
Radiation: Solar Heat	1120 600	W/m^2	ETS 300 019-2-1: T1.2, IEC 60068-2-2 Bb ETS 300 019-2-1: T1.2, IEC 60068-2-2 Bb
Chemically active substances	Not recommended		IEC TR 60271-3-1: 1C1L
Mechanically active substances	Not recommended		IEC TR 60271-3-1: 1S1

Vibration sinusoidal:
    Displacement
    Acceleration
    Frequency range
	
	1.5
	5
	2-9 9-200
		
		mm
		m/s^2
		Hz
			IEC TR 60271-3-1: 1M2

Shocks:
    Shock spectrum
    Duration
    Acceleration
	
	semi-sinusoidal
	1
	50
		
		ms
		m/s^2
			IEC 60068-2-27 Ea

4.2.4.2   Processing Life

ELS62 must be soldered to an application within 72 hours after opening the moisture barrier bag (MBB) it was stored in.

As specified in the IPC/JEDEC J-STD-033 Standard, the manufacturing site processing the modules should have ambient temperatures below 30°C and a relative humidity below 60%.

4.2.4.3   Baking

Baking conditions are specified on the moisture sensitivity label attached to each MBB (see Figure 57 for details):
- It is *not necessary* to bake ELS62, if the conditions specified in Section 4.2.4.1 and Section 4.2.4.2 were not exceeded.
- It is *necessary* to bake ELS62, if any condition specified in Section 4.2.4.1 and Section 4.2.4.2 was exceeded.

If baking is necessary, the modules must be put into trays that can be baked to at least 125°C. Devices should not be baked in tape and reel carriers at any temperature.

4.2.4.4   Electrostatic Discharge

Electrostatic discharge (ESD) may lead to irreversable damage for the module. It is therefore advisable to develop measures and methods to counter ESD and to use these to control the electrostatic environment at manufacturing sites.

Please refer to Section 3.6 for further information on electrostatic discharge.

4.3 Packaging

4.3.1 Tape and Reel

The single-feed tape carrier for ELS62 is illustrated in Figure 52. The figure also shows the proper part orientation. The tape width is 44mm and the ELS62 modules are placed on the tape with a 32-mm pitch. The reels are 330mm in diameter with a core diameter of 100mm. Each reel contains 500 modules.

4.3.1.1 Orientation
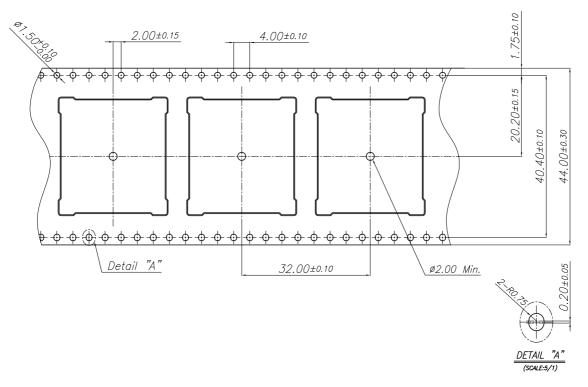
Figure 52: Carrier tape
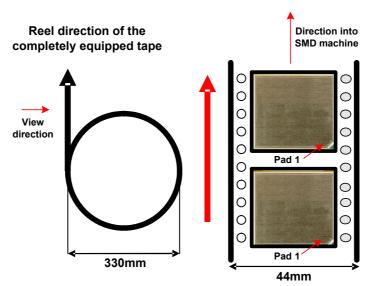
Figure 53: Reel direction

4.3.1.2   Barcode Label

A barcode label provides detailed information on the tape and its contents. It is attached to the reel.

Figure 54: Barcode label on tape reel
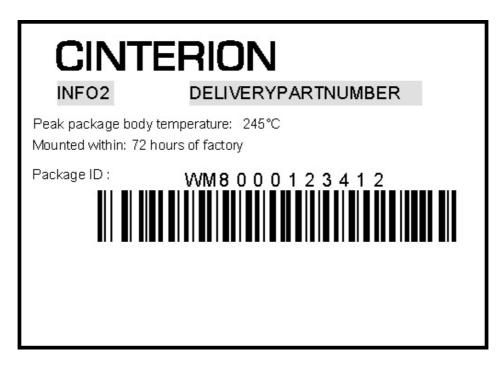
Figure 55: Barcode label on tape reel - layout

4.3.2 Shipping Materials

ELS62 is distributed in tape and reel carriers. The tape and reel carriers used to distribute ELS62 are packed as described below, including the following required shipping materials:
- Moisture barrier bag, including desiccant and humidity indicator card
- Transportation box

4.3.2.1 Moisture Barrier Bag

The tape reels are stored inside a moisture barrier bag (MBB), together with a humidity indicator card and desiccant pouches - see Figure 56. The bag is ESD protected and delimits moisture transmission. It is vacuum-sealed and should be handled carefully to avoid puncturing or tearing. The bag protects the ELS62 modules from moisture exposure. It should not be opened until the devices are ready to be soldered onto the application.
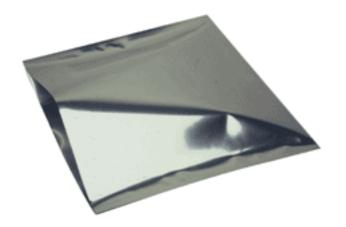
Figure 56: Moisture barrier bag (MBB) with imprint

The label shown in Figure 57 summarizes requirements regarding moisture sensitivity, including shelf life and baking requirements. It is attached to the outside of the moisture barrier bag.

Figure 57: Moisture Sensitivity Label

MBBs contain one or more desiccant pouches to absorb moisture that may be in the bag. The humidity indicator card described below should be used to determine whether the enclosed components have absorbed an excessive amount of moisture.

The desiccant pouches should not be baked or reused once removed from the MBB.

The humidity indicator card is a moisture indicator and is included in the MBB to show the approximate relative humidity level within the bag. Sample humidity cards are shown in Figure 58. If the components have been exposed to moisture above the recommended limits, the units will have to be rebaked.
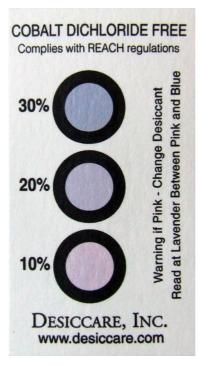
Figure 58: Humidity Indicator Card - HIC

A baking is required if the humidity indicator inside the bag indicates 10% RH or more.

4.3.2.2   Transportation Box

Tape and reel carriers are distributed in a box, marked with a barcode label for identification purposes. A box contains two reels with 500 modules each.

Figure 59: Sample of VP box label

Table 24: VP Box label information

No.	Information
1	Cinterion logo
2	Product name
3	Product ordering number
4	Package ID number of VP box (format may vary depending on the product)
5	Package ID barcode (Code 128)
6	Package ID Reel 1 (format may vary depending on the product)
7	Package ID Reel 2 (format may vary depending on the product)
8	Quantity of the modules inside the VP box (max. 1000 pcs)
9	Country of production
10	Der Grüne Punkt (Green Dot) symbol
11	Chinese RoHS symbol (see Table 31)
12	CE logo (CE mark on VP box label is present only for modules with CE imprinted on the shielding)
13	European Article Number (EAN-13) barcode
14	European Article Number, consists of 13 digits (EAN-13)

4.3.3　Trays

If small module quantities are required, e.g., for test and evaluation purposes, ELS62 may be distributed in trays (for dimensions see Figure 60). The small quantity trays are an alternative to the single-feed tape carriers normally used. However, the trays are not designed for machine processing. They contain modules to be (hand) soldered onto an external application (for information on hand soldering see [4]).

Trays are packed and shipped in the same way as tape carriers, including a moisture barrier bag with desiccant and humidity indicator card as well as a transportation box (see also Section 4.3.2).

Figure 60: Tray dimensions

5 Regulatory and Type Approval Information (TBD)

5.1 Directives and Standards

ELS62 is designed to comply with the directives and standards listed below.
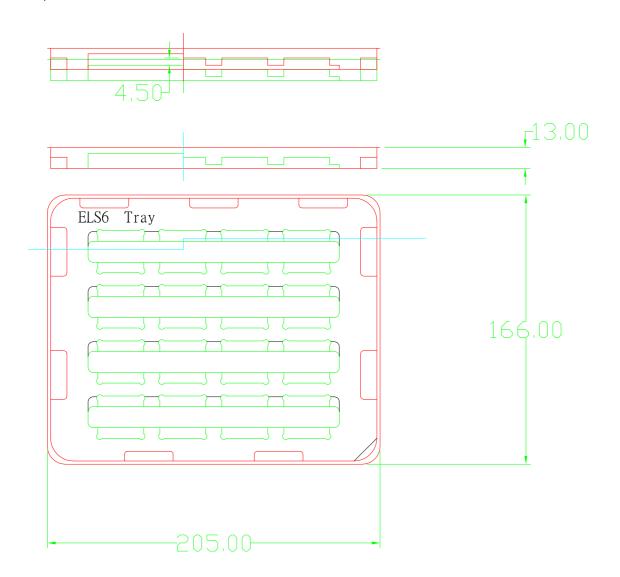
It is the responsibility of the application manufacturer to ensure compliance of the final product with all provisions of the applicable directives and standards as well as with the technical specifications provided in the "ELS62 Hardware Interface Description".[1]

Table 25: Directives

2014/53/EU	Directive of the European Parliament and of the council of 16 April 2014 on the harmonization of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/05/EC. The product is labeled with the CE conformity mark.
2002/95/EC (RoHS 1) 2011/65/EC (RoHS 2)	Directive of the European Parliament and of the Council of 27 January 2003 (and revised on 8 June 2011) on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS)
1907/2006/EC (REACH)	Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directive 91/155/EEC, 93/67/EC and 2000/21/EC. Cinterion® module comply with the REACH regulation that specifies a content of less than 0.1% per substance mentioned in the SVHC candidate list (Release 16.06.2014)

Table 26: Standards of European type approval

3GPP TS 51.010-1	Digital cellular telecommunications system (Release 7); Mobile Station (MS) conformance specification;
GCF-CC V3.79	Global Certification Forum - Certification Criteria
ETSI EN 301 511 V12.5.1	Global System for Mobile communications (GSM); Mobile Stations (MS) equipment; Harmonized Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU
ETSI EN 301 908-01 V13.1.1	IMT cellular networks; Harmonized Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 1: Introduction and common requirements
ETSI EN 301 908-02 V11.1.2	IMT cellular networks; Harmonized Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 2: CDMA Direct Spread (UTRA FDD) User Equipment (UE)

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1. Manufacturers of applications which can be used in the US shall ensure that their applications have a PTCRB approval. For this purpose they can refer to the PTCRB approval of the respective module.

Table 26: Standards of European type approval

ETSI EN 301 489-52 V1.1.0	Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 52: Specific conditions for Cellular Communication Mobile and portable (UE) radio and ancillary equipment; Harmonized Standard covering the essential requirements of article 3.1(b) of Directive 2014/53/EU
ETSI EN 301 908-13 V13.1.1	IMT cellular networks; Harmonized Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 13: evolved Universal Terrestrial Radio Access (E-UTRA) User Equipment (UE).
Draft ETSI EN 301 489-01 V2.2.3	Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements; Harmonized Standard covering the essential requirements of article 3.1(b) of Directive 2014/53/EU and the essential requirements of article 6 of Directive 2014/30/EU
ETSI EN 301489-52 V1.2.1(2021-11)	ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 19: Specific conditions for Receive Only Mobile Earth Stations (ROMES) operating in the 1,5 GHz band providing data communications and GNSS receivers operating in the RNSS band (ROGNSS) providing positioning, navigation, and timing data; Harmonised Standard covering the essential requirements of article 3.1(b) of Directive 2014/53/EU
ETSI EN 303 413 V1.1.1	Satellite Earth Stations and Systems (SES); Global Navigation Satellite System (GNSS) receivers; Radio equipment operating in the 1 164 MHz to 1 300 MHz and 1 559 MHz to 1 610 MHz frequency bands; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU
IEC 62368-1 (EN 62368-1, UL 62368-1)	Audio/video, information and communication technology equipment - Part 1: Safety requirements (for details see Section 5.1.1)

Table 27: Requirements of quality

IEC 60068	Environmental testing
DIN EN 60529	IP codes
EN 62311:2020	Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz - 300 GHz)

Table 28: Standards of the Ministry of Information Industry of the People's Republic of China

SJ/T 11363-2006	"Requirements for Concentration Limits for Certain Hazardous Substances in Electronic Information Products" (2006-06).
SJ/T 11364-2006	"Marking for Control of Pollution Caused by Electronic Information Products" (2006-06). According to the "Chinese Administration on the Control of Pollution caused by Electronic Information Products" (ACPEIP) the EPUP, i.e., Environmental Protection Use Period, of this product is 20 years as per the symbol shown here, unless otherwise marked. The EPUP is valid only as long as the product is operated within the operating limits described in the Thales Hardware Interface Description. Please see Table 29 for an overview of toxic or hazardous substances or elements that might be contained in product parts in concentrations above the limits defined by SJ/T 11363-2006.

Table 29: Toxic or hazardous substances or elements with defined concentration limits

部件名称 Name of the part	有毒有害物质或元素 Hazardous substances					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
金属部件 (Metal Parts)	O	O	O	O	O	O
电路模块 (Circuit Modules)	X	O	O	O	O	O
电缆及电缆组件 (Cables and Cable Assemblies)	O	O	O	O	O	O
塑料和聚合物部件 (Plastic and Polymeric parts)	O	O	O	O	O	O

O:

表示该有毒有害物质在该部件所有均质材料中的含量均在SJ/T11363-2006 标准规定的限量要求以下。

Indicates that this toxic or hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement in SJ/T11363-2006.

X:

表示该有毒有害物质至少在该部件的某一均质材料中的含量超出SJ/T11363-2006标准规定的限量要求。

Indicates that this toxic or hazardous substance contained in at least one of the homogeneous materials used for this part *might exceed* the limit requirement in SJ/T11363-2006.

5.2 SAR requirements specific to portable mobiles

Mobile phones, PDAs or other portable transmitters and receivers incorporating a GSM module must be in accordance with the guidelines for human exposure to radio frequency energy. This requires the Specific Absorption Rate (SAR) of portable ELS62 based applications to be evaluated and approved for compliance with national and/or international regulations.

Since the SAR value varies significantly with the individual product design manufacturers are advised to submit their product for approval if designed for portable use. For European-markets the relevant directives are mentioned below. It is the responsibility of the manufacturer of the final product to verify whether or not further standards, recommendations or directives are in force outside these areas.

Products intended for sale on European markets

EN 50360   Product standard to demonstrate the compliance of mobile phones with the basic restrictions related to human exposure to electromagnetic fields (300MHz - 3GHz)

EN 62311:2008   Assessment of electronic and electrical equipment related to human expo-sure restrictions for electromagnetic fields (0 Hz - 300 GHz)

Please note that SAR requirements are specific only for portable devices and not for mobile devices as defined below:
- Portable device:
  A portable device is defined as a transmitting device designed to be used so that the radiating structure(s) of the device is/are within 20 centimeters of the body of the user.
- Mobile device:
  A mobile device is defined as a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter's radiating structure(s) and the body of the user or nearby persons. In this context, the term "fixed location" means that the device is physically secured at one location and is not able to be easily moved to another location.

5.3 Reference Equipment for Type Approval

The Thales reference setup submitted to type approve ELS62 (including a special approval adapter for the DSB75) is shown in the following figure[1]:
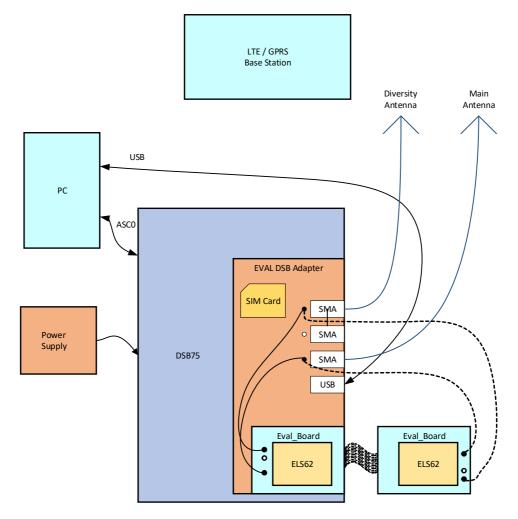
Figure 61: Reference equipment for Type Approval

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1. For RF performance tests a mini-SMT/U.FL to SMA adapter with attached 6dB coaxial attenuator is chosen to connect the evaluation module directly to the GSM test equipment instead of employing the SMA antenna connectors on the ELS62-DSB75 adapter as shown in Figure 61. The following products are recommended:
   Hirose SMA-Jack/U.FL-Plug conversion adapter HRMJ-U.FLP(40)
   (for details see http://www.hirose-connectors.com/ or http://www.farnell.com/
   Aeroflex Weinschel Fixed Coaxial Attenuator Model 3T/4T
   (for details see http://www.aeroflex.com/ams/weinschel/pdfiles/wmod3&4T.pdf)

6 Document Information

6.1 Revision History

Preceding document: "Cinterion® ELS62 Hardware Interface Description" Version 00.026
New document: "Cinterion® ELS62 Hardware Interface Description" Version **00.804**

Chapter	What is new
1.2	Updated key feature.
1.4	Update Figure 2.
2.1.1	Updated pad assignment table and figure style.
2.1.2	Updated values in Table 2.
2.1.7.2	Added I^{2}S interface.
2.1.7.3	Added Table 7.
2.1.8	Added Figure 16 and Figure 17.
2.1.8.3	Added this chapter.
3.2.5.2	Replaced TBD to 0.05V offset.
3.2.5.3	Replaced TBD to 0.05V offset.
3.3	Removed TBD for this chapter.
3.4.2	Added Minimizing Power Losses.
3.7	Updated figure and table in this chapter.
3.8	Updated the Vibration test value.
4.3.1.2	Added Figure 55.
4.3.2.2	Added Figure 59 and Table 24.

Preceding document: "Cinterion® ELS62 Hardware Interface Description" Version 00.001c
New document: "Cinterion® ELS62 Hardware Interface Description" Version 00.026

Chapter	What is new
1.2	Updated key feature.
2.1.1	Corrected issues in Pad assignment.
2.1.2	Updated values in Table 3.

Preceding document: "Cinterion® ELS62 Hardware Interface Description" Version 00.001c
New document: "Cinterion® ELS62 Hardware Interface Description" Version 00.001b

Chapter	What is new
2.1.1	Corrected issues in Pad assignment.

Preceding document: "Cinterion® ELS62 Hardware Interface Description" Version 00.001a
New document: "Cinterion® ELS62 Hardware Interface Description" Version 00.001b

Chapter	What is new
1.2	Updated the EGPRS and module weight and added LGA Devkit
2.1.1	Updated Pad assignment.
2.1.2	Updated values in Table 3.
2.1.8	Updated Analog Audio Interface.
2.1.10	Updated Pulse Counter.
3.2.3	Added Table 14:

Preceding document: "Cinterion® ELS62 Hardware Interface Description" Version 00.001
New document: "Cinterion® ELS62 Hardware Interface Description" Version 00.001a

Chapter	What is new
1.2	Updated the normal power range in Table 1.
2.1.2	Updated the Vimax to 4.5V and Vimin to 3.0V in Table 3.

New document: "Cinterion® ELS62 Hardware Interface Description" Version 00.001

Chapter	What is new
--	Initial document setup.

6.2   Related Documents

[1]   ELS62 AT Command Set
[2]   ELS62 Release Note
[3]   Universal Serial Bus Specification Revision 2.0, April 27, 2000
[4]   Application Note 48: SMT Module Integration
[5]   Differences between Selected Cinterion® Modules, Hardware Migration Guide
[6]   Cinterion® LGA DevKit User Guide
[7]   Cinterion® LGA DevKit online help

6.3 Terms and Abbreviations

Abbreviation	Description
ADC	Analog-to-digital converter
AGC	Automatic Gain Control
ANSI	American National Standards Institute
ARFCN	Absolute Radio Frequency Channel Number
ARP	Antenna Reference Point
ASC0/ASC1	Asynchronous Controller. Abbreviations used for first and second serial interface of ELS62
B	Thermistor Constant
BER	Bit Error Rate
BIP	Bearer Independent Protocol
BTS	Base Transceiver Station
CB or CBM	Cell Broadcast Message
CE	Conformité Européene (European Conformity)
CHAP	Challenge Handshake Authentication Protocol
CPU	Central Processing Unit
CS	Coding Scheme
CSD	Circuit Switched Data
CTS	Clear to Send
DAC	Digital-to-Analog Converter
dBm0	Digital level, 3.14dBm0 corresponds to full scale, see ITU G.711, A-law
DCE	Data Communication Equipment (typically modems, e.g. Thales module)
DCS 1800	Digital Cellular System, also referred to as PCN
DRX	Discontinuous Reception
DSB	Development Support Box
DSP	Digital Signal Processor
DSR	Data Set Ready
DTR	Data Terminal Ready
DTX	Discontinuous Transmission
EFR	Enhanced Full Rate
EGSM	Enhanced GSM
EIRP	Equivalent Isotropic Radiated Power
EMC	Electromagnetic Compatibility
ERP	Effective Radiated Power
ESD	Electrostatic Discharge
ETS	European Telecommunication Standard

Abbreviation	Description
ETSI	European Telecommunication Standards Institute
FCC	Federal Communications Commission (U.S.)
FDMA	Frequency Division Multiple Access
FR	Full Rate
GMSK	Gaussian Minimum Shift Keying
GPIO	General Purpose Input/Output
GPRS	General Packet Radio Service
GSM	Global Standard for Mobile Communications
HiZ	High Impedance
HR	Half Rate
I/O	Input/Output
IC	Integrated Circuit
IMEI	International Mobile Equipment Identity
ISO	International Standards Organization
ITU	International Telecommunications Union
kbps	kbits per second
LED	Light Emitting Diode
Li-Ion/Li+	Lithium-Ion
Li battery	Rechargeable Lithium Ion or Lithium Polymer battery
LPM	Link Power Management
Mbps	Mbits per second
MMI	Man Machine Interface
MO	Mobile Originated
MS	Mobile Station (GSM module), also referred to as TE
MSISDN	Mobile Station International ISDN number
MT	Mobile Terminated
NTC	Negative Temperature Coefficient
OEM	Original Equipment Manufacturer
PA	Power Amplifier
PAP	Password Authentication Protocol
PBCCH	Packet Switched Broadcast Control Channel
PCB	Printed Circuit Board
PCL	Power Control Level
PCM	Pulse Code Modulation
PCN	Personal Communications Network, also referred to as DCS 1800
PCS	Personal Communication System, also referred to as GSM 1900
PDU	Protocol Data Unit

Abbreviation	Description
PLL	Phase Locked Loop
PPP	Point-to-point protocol
PSK	Phase Shift Keying
PSU	Power Supply Unit
PWM	Pulse Width Modulation
R&TTE	Radio and Telecommunication Terminal Equipment
RAM	Random Access Memory
RF	Radio Frequency
RLS	Radio Link Stability
RMS	Root Mean Square (value)
RoHS	Restriction of the use of certain hazardous substances in electrical and electronic equipment.
ROM	Read-only Memory
RTC	Real Time Clock
RTS	Request to Send
Rx	Receive Direction
SAR	Specific Absorption Rate
SAW	Surface Accoustic Wave
SELV	Safety Extra Low Voltage
SIM	Subscriber Identification Module
SMD	Surface Mount Device
SMS	Short Message Service
SMT	Surface Mount Technology
SPI	Serial Peripheral Interface
SRAM	Static Random Access Memory
TA	Terminal adapter (e.g. GSM module)
TDMA	Time Division Multiple Access
TE	Terminal Equipment, also referred to as DTE
TLS	Transport Layer Security
Tx	Transmit Direction
UART	Universal asynchronous receiver-transmitter
URC	Unsolicited Result Code
USSD	Unstructured Supplementary Service Data
VSWR	Voltage Standing Wave Ratio

6.4   Safety Precaution Notes

The following safety precautions must be observed during all phases of the operation, usage, service or repair of any cellular terminal or mobile incorporating ELS62. Manufacturers of the cellular terminal are advised to convey the following safety information to users and operating personnel and to incorporate these guidelines into all manuals supplied with the product. Failure to comply with these precautions violates safety standards of design, manufacture and intended use of the product. Thales assumes no liability for customer's failure to comply with these precautions.

♥	When in a hospital or other health care facility, observe the restrictions on the use of mobiles. Switch the cellular terminal or mobile off, if instructed to do so by the guidelines posted in sensitive areas. Medical equipment may be sensitive to RF energy. The operation of cardiac pacemakers, other implanted medical equipment and hearing aids can be affected by interference from cellular terminals or mobiles placed close to the device. If in doubt about potential danger, contact the physician or the manufacturer of the device to verify that the equipment is properly shielded. Pacemaker patients are advised to keep their hand-held mobile away from the pacemaker, while it is on.
✈	Switch off the cellular terminal or mobile before boarding an aircraft. Make sure it cannot be switched on inadvertently. The operation of wireless appliances in an aircraft is forbidden to prevent interference with communications systems. Failure to observe these instructions may lead to the suspension or denial of cellular services to the offender, legal action, or both.
🔥	Do not operate the cellular terminal or mobile in the presence of flammable gases or fumes. Switch off the cellular terminal when you are near petrol stations, fuel depots, chemical plants or where blasting operations are in progress. Operation of any electrical equipment in potentially explosive atmospheres can constitute a safety hazard.
📺	Your cellular terminal or mobile receives and transmits radio frequency energy while switched on. Remember that interference can occur if it is used close to TV sets, radios, computers or inadequately shielded equipment. Follow any special regulations and always switch off the cellular terminal or mobile wherever forbidden, or when you suspect that it may cause interference or danger.
🚗	Road safety comes first! Do not use a hand-held cellular terminal or mobile when driving a vehicle, unless it is securely mounted in a holder for speakerphone operation. Before making a call with a hand-held terminal or mobile, park the vehicle. Speakerphones must be installed by qualified personnel. Faulty installation or operation can constitute a safety hazard.
SOS	IMPORTANT! Cellular terminals or mobiles operate using radio signals and cellular networks. Because of this, connection cannot be guaranteed at all times under all conditions. Therefore, you should never rely solely upon any wireless device for essential communications, for example emergency calls. Remember, in order to make or receive calls, the cellular terminal or mobile must be switched on and in a service area with adequate cellular signal strength. Some networks do not allow for emergency calls if certain network services or phone features are in use (e.g. lock functions, fixed dialing etc.). You may need to deactivate those features before you can make an emergency call. Some networks require that a valid SIM card be properly inserted in the cellular terminal or mobile.

7 Appendix

7.1 List of Parts and Accessories

Table 30: List of parts and accessories

Description	Supplier	Ordering information
ELS62-W	Thales	Standard module Thales IMEI: Packaging unit (ordering) number: L30960-N7300-A100 Module label number: L30960-N7300-A100.[1]
ELS62-E	Thales	Standard module Thales IMEI: Packaging unit (ordering) number: L30960-N7310-A100 Module label number: L30960-N7310-A100.
ELS62-I	Thales	Standard module Thales IMEI: Packaging unit (ordering) number: L30960-N7320-A100 Module label number: L30960-N7320-A100.
ELS62-BR	Thales	Standard module Thales IMEI: Packaging unit (ordering) number: L30960-N7330-A100 Module label number: L30960-N7330-A100.
ELS62-C	Thales	Standard module Thales IMEI: Packaging unit (ordering) number: L30960-N7340-A100 Module label number: L30960-N7340-A100.
ELS62-W Evaluation Module	Thales	Ordering number: L30960-N7301-A100
ELS62-E Evaluation Module	Thales	Ordering number: L30960-N7311-A100
ELS62-I Evaluation Module	Thales	Ordering number: L30960-N7321-A100
ELS62-BR Evaluation Module	Thales	Ordering number: L30960-N7331-A100
ELS62-C Evaluation Module	Thales	Ordering number: L30960-N7341-A100
DSB Mini Compact Evaluation Board	Thales	Ordering number: L30960-N0030-A100
LGA DevKit	Thales	LGA DevKit consists of Cinterion® LGA DevKit SM Base PCB: Ordering number: L30960-N0111-A100 Cinterion® LGA DevKit Socket SML: Ordering number: L30960-N0110-A100

1. Note: At the discretion of Thales, module label information can either be laser engraved on the module's shielding or be printed on a label adhered to the module's shielding.

7.1 List of Parts and Accessories

Table 31: Molex sales contacts (subject to change)

Molex For further information please click: http://www.molex.com	Molex Deutschland GmbH Otto-Hahn-Str. 1b 69190 Walldorf Germany Phone: +49-6227-3091-0 Fax: +49-6227-3091-8100 Email: mxgermany@molex.com	American Headquarters Lisle, Illinois 60532 U.S.A. Phone: +1-800-78MOLEX Fax: +1-630-969-1352
Molex China Distributors Beijing, Room 1311, Tower B, COFCO Plaza No. 8, Jian Guo Men Nei Street, 100005 Beijing P.R. China Phone: +86-10-6526-9628 Fax: +86-10-6526-9730	Molex Singapore Pte. Ltd. 110, International Road Jurong Town, Singapore 629174 Phone: +65-6-268-6868 Fax: +65-6-265-6044	Molex Japan Co. Ltd. 1-5-4 Fukami-Higashi, Yamato-City, Kanagawa, 242-8585 Japan Phone: +81-46-265-2325 Fax: +81-46-265-2365

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